Final Noise Technical Report

Franklin Blvd: I-5 Bridge to McVay Hwy (Springfield), ODOT Key #:17217

Springfield, Oregon

June 2015

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Acronyms, Abbreviations, and Useage

CFR	Code of Federal Regulations
dBA	A-weighted decibels
EB	Eastbound
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
I-5	Interstate 5
L_{eq}	equivalent sound level (the steady A-weighted sound level over any specified period of time that has the same acoustic energy as the fluctuating noise during that period; a measure of cumulative acoustical energy)
$L_{eq\ (h)}$	hourly equivalent sound level
L_{max}	maximum noise levels
L_{min}	minimum noise levels
NAAC	noise abatement approach criteria (ODOT)
NAC	noise abatement criteria (FHWA)
NB	northbound
ODOT	Oregon Department of Transportation
Receiver	modeling or measurement location that represents noise sensitive land uses; can represent multiple receptors or equivalent units
Receptor	an activity or unit represented by a measured or modeled receiver, also called an equivalent unit (subset of receiver)
SB	southbound
SEL	sound exposure level
SR	state route
TNM®	Traffic Noise Model
USGS	United States Geological Survey
WB	westbound

Chapter 1 Summary

The Franklin Boulevard: I-5 Bridge to McVay Highway (Springfield) Project described in this report as the Franklin Boulevard Project proposes to widen Franklin Boulevard between a location 1/4-mile east of I-5 to McVay Highway in the City of Springfield, Oregon (shown in Figure 1 in Chapter 2). The project includes four new roundabouts along Franklin Boulevard between Glenwood Boulevard and McVay Highway. Three new bus pull-outs at roundabouts are included in the project design which also includes new medians, bike lanes, planter strips, parking and access to parking, and sidewalks. A detailed project description is included in Chapter 2 and cross-sections for the proposed project alignment are shown on Figure 2 (in Chapter 2).

Through a review of project elements and coordination with the Oregon Department of Transportation (ODOT), it was determined that this project is defined as a Type I Project requiring a traffic noise study. The Type I determination is because the project includes additional through lanes that shift traffic closer to noise sensitive land uses and the project involves the removal of buildings that would no longer block the line-of-sight between nearby homes and traffic on the new alignment (ODOT 2011). A technical memorandum is included in Appendix A that documents the project type determination.

A technical noise analysis was performed to document the existing conditions, No Build Alternative and Build Alternative future conditions along the Franklin Boulevard Project. The traffic noise analysis complies with guidelines established by the Federal Highway Administration (FHWA) and the ODOT.

Land uses in the area studied are a mix of commercial and light industrial businesses with direct access to Franklin Boulevard. Residential properties are located to the north and south of the project area with the Ponderosa Village mobile home park located north of Franklin Boulevard at Lexington Avenue. Other noise sensitive land uses near the project include a community resource center (Planned Parenthood) and commercial recreation (Camp Putt Adventure Golf Park).

The noise levels along the current roadways were measured at six locations, and existing and future No Build Alternative and Build Alternative peak noise levels were modeled at 14 locations using the FHWA's Traffic Noise Model (TNM®). Modeled noise levels range from 59 dBA $L_{eq(h)}$ to 65 dBA $L_{eq(h)}$ for the existing peak noise conditions. For the No Build Alternative modeled noise levels ranged from 60 dBA $L_{eq(h)}$ to 67 dBA $L_{eq(h)}$. Future Build Alternative modeled noise levels ranged from 61 dBA $L_{eq(h)}$ to 68 dBA $L_{eq(h)}$.

Existing noise levels reach the ODOT Noise Approach Abatement Criteria (NAAC) at five apartment units and at the Camp Putt Adventure Golf Park located on Franklin Boulevard. Future no build noise levels reach the ODOT NAAC at the same five apartments and a golf park as in the existing conditions and includes the outdoor sitting area at Planned Parenthood. Future build noise levels reach the ODOT NAAC at the same five apartments and at the outdoor sitting area at Planned Parenthood.

Noise abatement was considered at both locations predicted to experience noise levels above the ODOT NAAC. At both locations a feasible abatement option including traffic management, alignment alterations, buffer zones, and noise barriers was not found to be viable to reduce noise levels at sites with impacts. Chapter 6 of this report provides details of abatement considerations. No noise abatement is recommended for this project.

No sites are predicted to experience a substantial increase of 10 dBA or more in future noise levels with the project.

During project construction, areas adjacent would be exposed to construction noise in addition to the traffic-related noise. Impacts during construction are of short duration and standard specifications for noise control will minimize or eliminate impacts during construction.

A copy of this report will be made available to the City of Springfield Community Planning Department by ODOT. This report will serve to inform the City of the effects of the roadway and roadway-construction-related noise in the area studied. The information contained within this report can assist the City in its planning process.

Based on the results of this report and future traffic volumes and speeds included in this report, areas within 90 feet of Franklin Boulevard may experience noise levels up to the ODOT NAAC of 65 dBA for residential land use and other outdoor land uses such as playfields and parks. Commercial and related business uses located within 15 feet of Franklin Boulevard may experience noise levels up to the ODOT NAAC of 70 dBA for hotels, offices, and similar uses such as restaurants and bars. It is recommended that the City of Springfield use this information as a guide when developing future land use plans, zoning, or building code requirements. The use of this information may assist local government with future development plans and thereby result in development that is consistent with the noise environment.

Chapter 2 Project Description and Land Use

2.1 Project Description and Purpose

The Franklin Boulevard Project proposes to widen Franklin Boulevard between a location 1/4-mile east of I-5 to McVay Highway in the City of Springfield, Oregon (Figure 1). The project includes four new roundabouts along Franklin Boulevard between Glenwood Boulevard and McVay Highway. Cross-sections for the proposed project alignment are shown on Figure 2.

The Project Corridor's western terminus is a location on Franklin Boulevard/Highway 126B at approximately M.P. 0.33 (approximately 1/4-mile east of I-5). The Project Corridor's eastern terminus is on the approaches to the Main Street and South A Street Bridges over the Willamette River, at approximately M.P. 1.2, immediately east of the intersection of Franklin Boulevard and McVay Highway. These termini are the limits of the proposed improvements to Franklin Boulevard called for by the City of Springfield's comprehensive plan.

Franklin Boulevard is a principal east-west artery connecting downtown Eugene, the University of Oregon, and downtown Springfield. Franklin Boulevard is the main arterial through the Glenwood area, which comprises the Project Area, and the area south to Interstate-5 (I-5). The EmX (Emerald Express) bus rapid transit (BRT) service, which connects downtown Eugene and downtown Springfield, travels along Franklin Boulevard. The roadway is a five-lane arterial with minimal access control, substandard and disjointed sidewalks, limited pedestrian crossings, BRT stops with shelter coverage, and no bicycle lanes or paths. The right of way varies from 70 to 75 feet in width. Bicyclists currently use the outside of the right lane or the sidewalks; there are no shoulders. Stormwater from the facility is not treated before it is discharged to the Willamette River. The existing roadway in the Project Area is under the jurisdiction of the ODOT and is part of the National Highway System. The jurisdictional transfer of Franklin Boulevard from ODOT to the City of Springfield was finalized in July of 2014. McVay Highway will remain under ODOT jurisdiction. The existing speed limit is 35 mph.

The proposed roadway improvements included in the Franklin Boulevard Project would result in a wider cross-section for Franklin Boulevard between a location 1/4-mile east of I-5 and McVay Highway. The existing roadway width varies between 70 and 75 feet. From Glenwood Boulevard to Henderson Avenue, Franklin Boulevard's cross-section would be expanded to 128 feet; between Henderson Avenue and Mississippi Avenue, Franklin Boulevard's cross-section would be expanded to 175 feet; and between Mississippi Avenue and McVay Highway, Franklin Boulevard's cross-section would be expanded to 155 feet. The centerline of the new right-of-way cross-section would be placed approximately at the centerline of the existing right-of-way. The future speed limit is 35 mph with 25 mph within the four roundabouts.

Four new roundabouts on Franklin Boulevard at Glenwood Boulevard, Henderson Avenue, Mississippi Avenue, and McVay Highway would connect the new alignment cross-sections. The roundabouts would include connections to existing streets intersecting Franklin Boulevard and provide connections to future planned roads as described in the Glenwood Refinement Plan. The design provides bus rapid transit stations with pull-outs at three of the roundabouts. The cross sections and diameters of the roundabouts (and their footprints) have been determined at a conceptual level and the eastern roundabout is a dual or "dog bone" roundabout. Additional Project elements include medians, through lanes, bike lanes, planter strips, parking and access to parking, and sidewalks. Several buildings located along Franklin Boulevard would be removed to as part of this project. The buildings that are located within the project alignment house commercial and light industrial businesses and are shown in Figure 3. No homes are planned for removal as a part of this project.

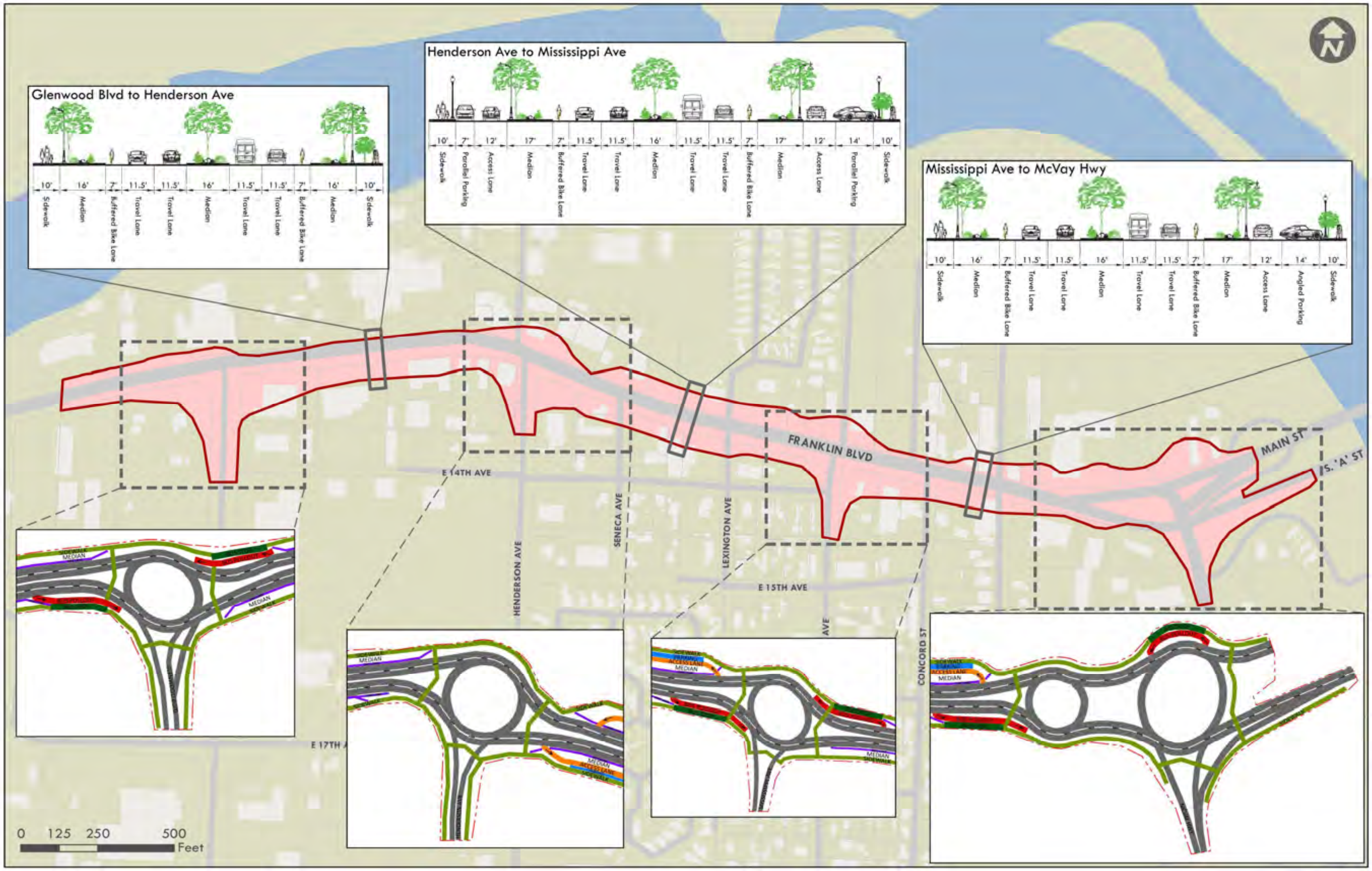
A noise study is required for this project because the project is defined as a Type I Project that includes additional through lanes that shift traffic closer to noise sensitive land uses and involves the removal of buildings that would no longer block the line-of-sight between nearby homes and traffic on the new alignment (ODOT 2011).

The purpose of this noise study is to describe the existing noise environment, predict future noise levels, evaluate potential noise abatement, if applicable, and evaluate construction noise effects.

Figure 1. Project Location

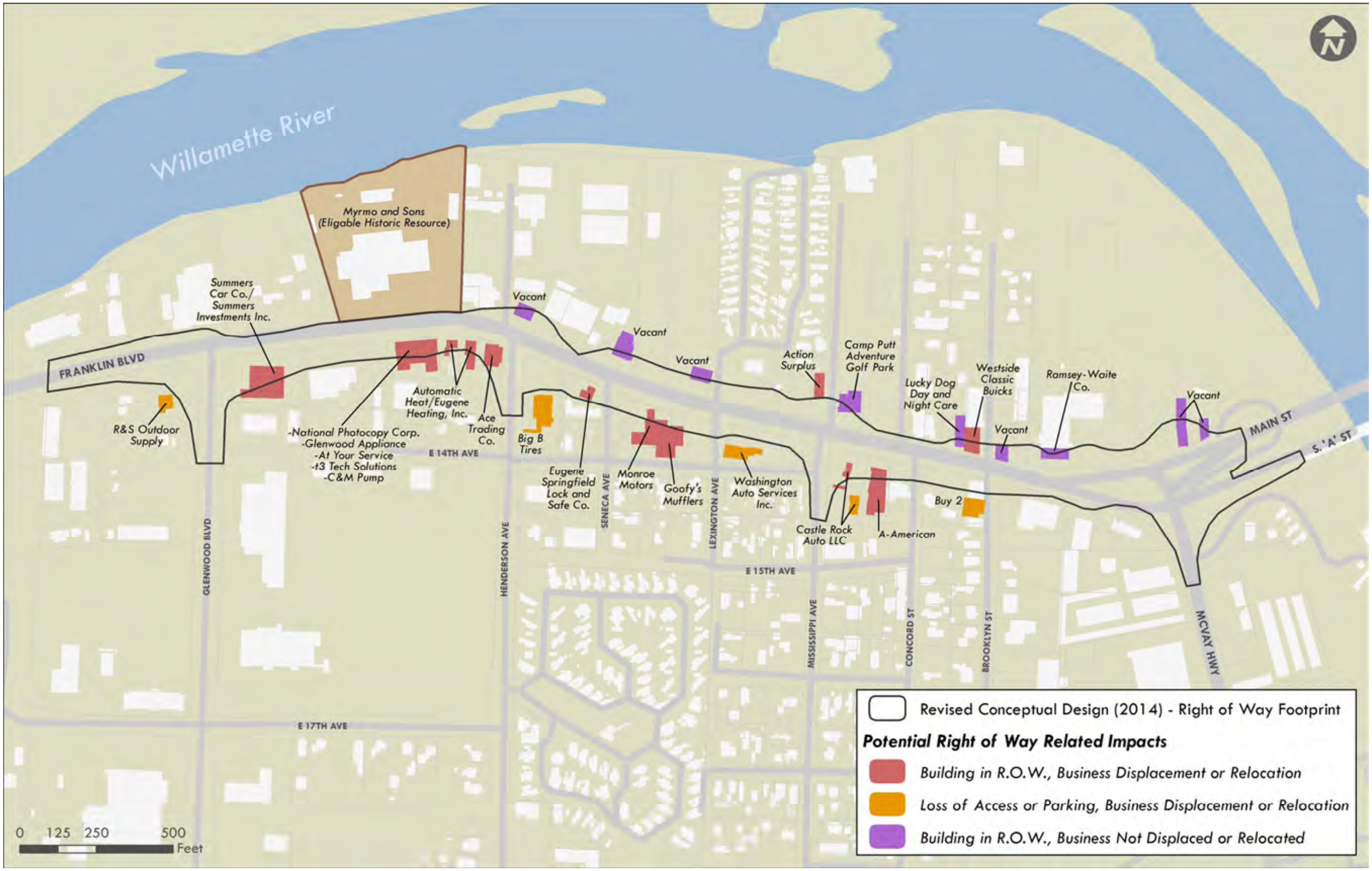
Source: ESRI, 2014.

Figure 2. Project Design



Source: AECOM, 2014.

Figure 3. Potential Right of Way Related Displacements



Source: AECOM, 2014.

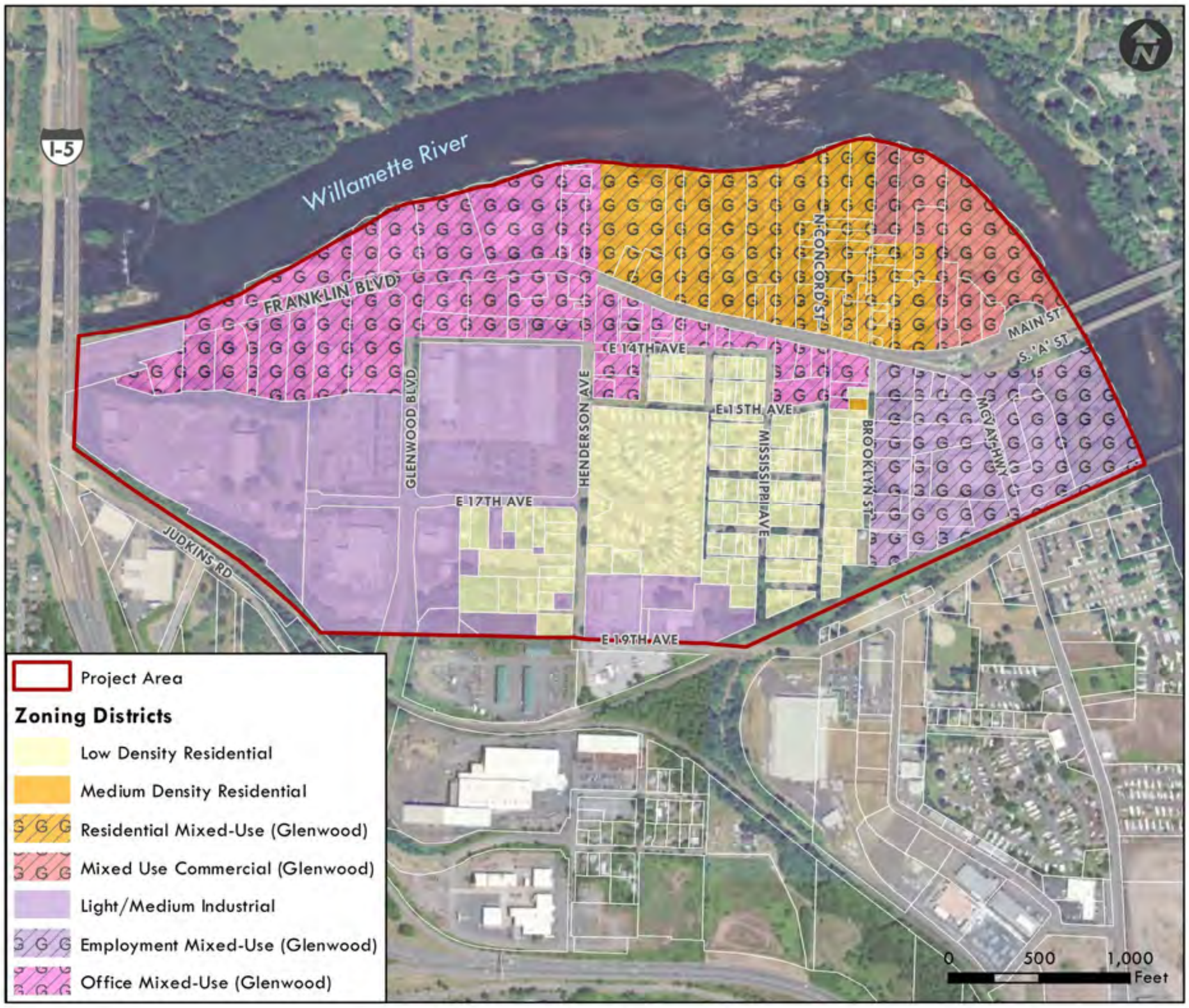
2.2 Zoning

Figure 4 shows the City of Springfield zoning around the area studied. The City of Springfield's zoning designates current land use and planned future land use development. Zoning districts in the noise study area include the following:

- Low Density Residential
- Medium Density Residential
- Residential Mixed-Use (Glenwood)
- Mixed-Use Commercial (Glenwood)
- Light/Medium Industrial
- Employment Mixed-Use (Glenwood)
- Office Mixed-Use (Glenwood)

Land uses in the area studied are a mix of commercial and light industrial businesses with direct access to Franklin Boulevard. Areas of residential properties are located to the north and south of the project area with the Ponderosa Village mobile home park located north of Franklin Boulevard at Lexington Avenue. Other noise sensitive land uses near the project include a community resource center (Planned Parenthood) and commercial recreation (Camp Putt Adventure Golf Park). No permitted development in the area was identified with the City of Springfield.

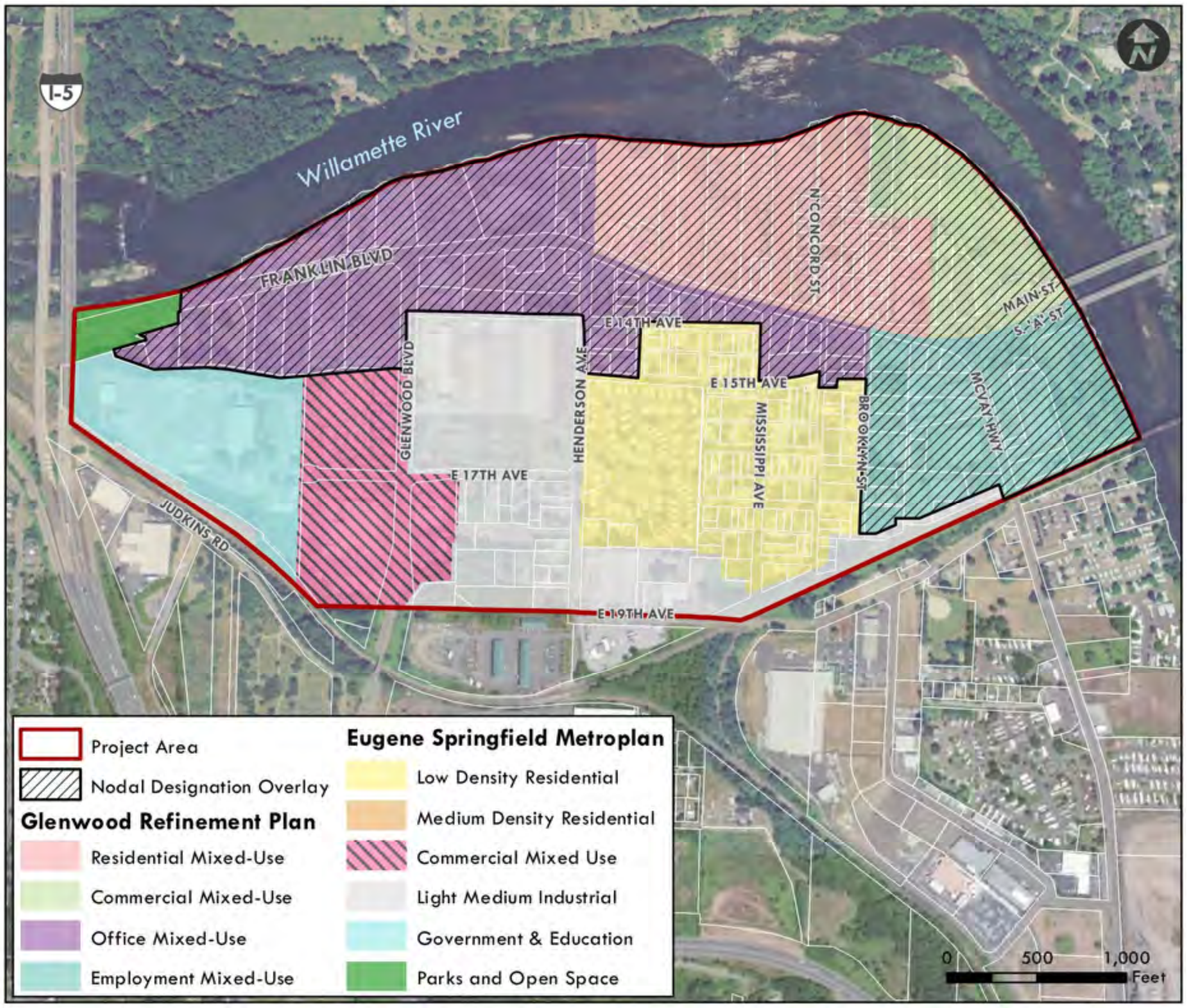
Figure 4. Project Vicinity Zoning and Land Use



Source: City of Springfield, 2014.

Figure 5 shows comprehensive plan designations in the area surrounding the Franklin Boulevard Project. The noise study area is located within lands designated as Office Mixed-Use, Residential Mixed-Use, Employment Mixed-Use, and Commercial Mixed-Use.

Figure 5. Comprehensive Plan/General Land Use Designation



Source: City of Springfield, 2014

Chapter 3 Methodology

3.1 Methods

An introduction to acoustics is included in Appendix B to provide additional details for methods used in this analysis.

Ambient noise levels were measured for 15-minute periods at six locations near the project area to describe the existing noise environment, identify major noise sources in the project area, validate the noise prediction model, and characterize the weekday background environmental noise levels (see Section 4.1). Measurements were conducted on November 10, 2014, with a calibrated Larson Davis Model 820 noise meter, which complies with ANSI S1.4 Standard for a Type I accuracy instrument. Calibration forms for all instruments used for field monitoring are provided in Appendix F of this report. In some cases measurement locations represent larger clusters of noise-sensitive receptors near the proposed project. Measurements were performed at outdoor use areas of private residences near the project area when possible. Some measurements were performed at publically accessible locations adjacent to outdoor use locations. Locations were selected to represent existing traffic noise levels near the project area for use as model validation points. Existing noise levels were then modeled at 14 locations that are representative of properties that could potentially be affected by the project.

The six measured sites represented 20 residences located near the project and one area of benches outside a commercial business that are frequently used as a break area. Eight additional modeled-only sites were added to the six measured sites totaling 14 modeled receivers [representing approximately 35 residences, one commercial golf park repented by modeled site R8, one outdoor area at a community institution (Planned Parenthood) represented by modeled site R1, and two break areas outside commercial businesses] were also included in the TNM® model to provide predicted traffic noise levels for receivers that could be impacted by the project. The modeling locations were chosen because they are representative of outdoor ground floor areas of frequent human use, such as residential front or back yards (ODOT 2011). The locations of all 14 receivers can be seen in Figures 6, 7, and 8 in Section 4.2.

TNM® Version 2.5 computer model (FHWA 2004) was used to predict $L_{eq(h)}$ traffic noise levels as shown in Section 4.1. TNM® was used to predict noise levels at discrete points by considering interactions between different noise sources and the effects of topographical features on the propagation of noise. The model estimates the traffic noise level at a receptor location resulting from a series of straight-line roadway segments. Noise emissions from free-flowing traffic depend on the number of automobiles, medium trucks, and heavy trucks per hour; vehicular speed; and reference noise emission levels of specified vehicles. TNM® also considers effects of intervening barriers, topography, trees, and atmospheric absorption. By intent and design, noise from sources other than traffic is not included. Therefore, when non-traffic noise, such as aircraft, is considerable in an area, the TNM® results can be slightly less than the measured noise levels.

Analysis of sound levels at noise sensitive land uses were conducted following standard ODOT and FHWA noise policy guidance. The conceptual alignment developed through workshops focusing on impact avoidance was provided to the traffic noise team. The noise model was developed by using the roadway centerline from the project design file and digitized into TNM. The roadway centerline was also used to develop roadway lanes at the roundabouts which were each divided into separate roadways to apply 25 mph speeds. The straightaway portions of the future design for Franklin Boulevard were modeled to maintain the existing 35 mph speed limit.

For this reason, the noise monitoring results were used to validate the TNM® model by comparing the predicted (modeled) and measured noise levels at the six measurement locations using the traffic count data obtained during the measurement periods.

As standard practice, base maps were exported as DXF files and imported into the TNM® package. In addition, ArcGIS was used to develop the TNM® model. Design drawings were used to locate and verify roadway widths and for additional base mapping. Major roadways, nearby residential structures and sensitive receptors were digitized into the model. The United States Geological Survey (USGS) 7.5-minute Digital Elevation Model was also used (USGS 2004). Topographical features were not added to the model as the area is generally flat throughout. Future project modeling files reflect the planned removal of several structures located along Franklin Boulevard that is part of the proposed project.

Per ODOT policy, a comparison of the peak truck hour $\mathbf{L_{eq(h)}}$ and peak vehicle hour $\mathbf{L_{eq(h)}}$ is typically performed. A comparison is made because noise from truck traffic has been found to be much louder than automobile traffic, with one truck equaling approximately 47 passenger cars on average (NYC 2010). Therefore, the peak truck hour is often found to be noisier than the peak vehicular hour, although it may have lower overall traffic volumes. For this study, peak hour volumes were used in the existing conditions (2013), No Build Alternative (2035), and Build Alternative (2035) after a comparison of peak hour and peak truck hour noise levels showed peak hour noise levels were higher. Results of the comparison of peak hour and peak truck hour noise levels can be found in Appendix C. Traffic data and speeds were provided by the City of Springfield for use in this noise study. Future Build Alternative speeds on Franklin Boulevard were 25 mph as suggested for multi-lane roundabouts with a radius of 90 feet or more (NCHRP, 2014). Traffic counts were also recorded during field measurements for model validation. All traffic volumes used for this noise study are documented in Appendix C.

Construction noise was qualitatively assessed using FHWA reference levels. Suggested construction noise mitigation measures are provided for inclusion in contractor documents.

3.2 Noise Regulations and Impact Criteria

Applicable noise regulations and guidelines provide a basis for evaluating potential noise impacts. For highway transportation projects with FHWA involvement, the *Federal-Aid Highway Act of 1970* and the associated implementing regulations (23 CFR 772) govern the analysis and abatement of traffic noise impacts. The regulations require that potential noise impacts in areas of frequent human use be identified during the planning and design of a highway project. The noise regulations govern noise prediction requirements, noise analyses, noise abatement criteria (NAC), and requirements for informing local officials. The NAC are used to determine when a noise impact would occur. The NAC differ depending on the type of land use under analysis. For example, the NAC for residences (67 dBA) is lower than the NAC for commercial areas (72 dBA).

3.2.1 ODOT Noise Policy

ODOT implements FHWA noise regulations in the State of Oregon in accordance with the ODOT Noise Manual (ODOT 2011). According to this manual, a noise impact occurs when the future noise level for a build alternative results in a substantial increase in the noise level (defined as a 10 dBA or more increase over the existing noise levels) or when the future noise level for a Build Alternative approaches or exceeds the FHWA NAC. ODOT noise policy defines the Noise Abatement Approach Criteria (NAAC) as 2 dBA less than the FHWA NAC. This report complies with the current ODOT manual. Table 1 shows the ODOT NAAC and FHWA NAC.

Table 1. FHWA Noise Abatement Criteria—ODOT Noise Abatement Approach Criteria Hourly A-Weighted Sound Level Decibels (dBA)

Activity Category	Activity Criteria[a] Leq (h)		Evaluation Location	Activity Description
	FHWA NAC[b]	ODOT NAAC[c]		
A	57	55	Exterior	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[c]	67	65	Exterior	Residential
C[c]	67	65	Exterior	Active sports areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities, parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, recreation areas, Section 4(f) sites, schools, television studios, trails and trails crossings.
D	52	50	Interior	Auditoriums, campgrounds, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or non-profit institutional structures, radio studios, recording studios, schools, and television studios.
E[c]	72	70	Exterior	Hotels, motels, offices, restaurants/bars, and other develop lands, properties, or activities not included in A through D or F.
F	—	—	—	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, shipyards, utilities (water resources, water treatment, electrical), and warehousing.
G	—	—	—	Undeveloped lands that are not permitted.[d]

Notes:
[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

3.2.2 Oregon Department of Environmental Quality Noise Policy

The Oregon Department of Environmental Quality Chapter 340 Division 35 sets allowable noise levels for individual vehicles and for industrial and commercial uses. Maximum allowable noise levels for in-use vehicles in Oregon are determined by vehicle type, operating conditions, and model year (http://www.deq.state.or.us/aq/rules/div35/table2.pdf).

3.2.3 Local Noise Rules

The City of Springfield regulates noise from any mechanical devices through the city's municipal noise code, Chapter 5.220 Noise (Springfield, 2015). Lane County limits sounds that exceed 10 dBA between the hours of 10:00 PM to 7:00 AM or 12 dBA between the hours of 6:00 PM to 10:00 PM over the ambient noise level within the sound sensitive unit with a window ajar and measured from no closer than 3 feet from the window (Lane County, 2015). Lane County allows for exceptions to these rules which may apply to sound created by construction activities and for vehicle traffic on public roads.

Chapter 4 Existing Noise Levels

4.1 Measurements and Noise Model Validation

Existing noise levels were measured at six locations (Section 4.2). Fifteen-minute noise measurements were taken during the afternoon of November 10, 2014 and traffic conditions were observed throughout the day. The measured noise levels, traffic counts, and average vehicle speeds taken during the noise measurements were used to validate the TNM® traffic noise model (as described in Chapter 3). Traffic noise was the dominant noise source in the project area although other non-traffic noises, such as distant aircraft noise and noise from animals and yard maintenance may temporarily influence noise levels in the surrounding area. No non-traffic related noises were observed during field measurements on November 10, 2014. Non-traffic-related noise sources may influence noise levels for short periods of the day; however, the dominant noise source in the study area is from traffic on Franklin Boulevard.

Noise levels at the six measurement sites ranged from 58 dBA L_{eq} to 69 dBA L_{eq}, depending on the proximity to Franklin Boulevard (see Table 2). The noise measurements were performed during satisfactory weather conditions for performing noise measurements in the daytime on November 10, 2014. The temperatures during measurement periods ranged from 50 to 54 degrees Fahrenheit with partial sunny skies, no precipitation, and low wind speeds during measurement periods. Descriptions of each measurement site follow:

- Measurement Site 1 was located at a commercial parking lot at 3403 Franklin Boulevard. Site 1 was located approximately 80 feet south of vehicles traveling on Franklin Boulevard and at a similar elevation as Franklin Boulevard. The monitored noise level at Site 1 was 69 dBA L_{eq}.
- Measurement Site 2 was located in the front yard of a 5-unit apartment building facing Franklin Boulevard. The street address at Site 2 is 3787 East 14th Avenue. Site 2 was located approximately 60 feet south of Franklin Boulevard eastbound lanes and at a similar elevation as Franklin Boulevard. The monitored noise level at Site 2 was 64 dBA L_{eq}.
- Measurement Site 3 was located at an outdoor use space within the Ponderosa Village mobile home park at 3998 Franklin Boulevard. Site 3 was located approximately 160 feet north of Franklin Boulevard and at a similar elevation as Franklin Boulevard. The monitored noise level at Site 3 was 58 dBA L_{eq}.
- Measurement Site 4 was located at a front yard of a home at 1400 Mississippi Avenue. Site 4 was located approximately 170 feet south of vehicles traveling on Franklin Boulevard and at a similar elevation as Franklin Boulevard. The monitored noise level at Site 4 was 61 dBA L_{eq}.
- Measurement Site 5 was located at a front yard at 1450 Brooklyn Avenue. Site 5 was located approximately 180 feet south of vehicles traveling on Franklin Boulevard and at a similar elevation as Franklin Boulevard. The monitored noise level at Site 5 was 61 dBA L_{eq}.
- Measurement Site 6 was located at an outdoor use space at a 3-unit building at 4399 Franklin Boulevard. Site 6 was located approximately 100 feet south of Franklin Boulevard and at a similar elevation as Franklin Boulevard. The monitored noise level at Site 6 was 60 dBA L_{eq}.

Table 2. Noise Measurement Data and TNM Model Validation

Noise Receptor Number	Land Use	Date/ Time	Observed Traffic Volumes (10 minute counts)		Observed Traffic Speed (mph)	Approximate Distance to Edge of Pavement (feet)	Measured Noise Level (dBA L_{eq})	Modeled Noise Level for Validation (dBA L_{eq})	Difference between Modeled and Measured Noise Level (dBA L_{eq})
			Franklin Blvd. Eastbound	Franklin Blvd. Westbound					
M1	Commercial	11/10/2014 12:15 PM	Autos: 146 Medium Trucks: 2 Heavy Trucks: 2	Autos: 128 Medium Trucks: 2 Heavy Trucks: 4	40	80	69	66	-3
M2	Residential	11/10/2014 4:30 PM	Autos: 78 Medium Trucks: 2 Heavy Trucks: 8	Autos: 108 Medium Trucks: 2 Heavy Trucks: 8	35	60	64	66	2
M3	Residential	11/10/2014 1:55 PM	Autos: 106 Medium Trucks: 0 Heavy Trucks: 4	Autos: 106 Medium Trucks: 0 Heavy Trucks: 4	35	160	58	61	3
M4	Residential	11/10/2014 4:50 PM	Autos: 78 Medium Trucks: 2 Heavy Trucks: 2	Autos: 94 Medium Trucks: 0 Heavy Trucks: 4	35	170	61	60	-1
M5	Residential	11/10/2014 1:00 PM	Autos: 148 Medium Trucks: 0 Heavy Trucks: 3	Autos: 117 Medium Trucks: 0 Heavy Trucks: 4	35	180	61	60	-1
M6	Residential	11/10/2014 11:35 AM	Autos: 91 Medium Trucks: 0 Heavy Trucks: 2	Autos: 86 Medium Trucks: 0 Heavy Trucks: 2	40	100	60	61	1

Source: Parsons Brinckerhoff Field Observations November, 2014.
Notes:
Traffic from other roadways was not audible and was not counted during measurement.

For noise model validation, measured noise levels, traffic counts, and average traffic speeds taken during the measurements were used to validate the TNM® traffic noise model. The project area and surrounding topography is generally flat and topographic features were not included in the modeling. The existing conditions TNM® model was validated by ensuring that the modeled noise levels at each of the six measured sites were within +/-3 dBA of the measured levels. Table 2 shows that the TNM® model results agree within (+/- 3 dBA) when compared to the measured noise levels.

Verification of the modeled and measured noise levels within 3 dBA indicates that the model is accurately representing the noise levels in this area. Thus, the model can be relied upon to accurately predict the noise levels for existing and future peak vehicle hour traffic conditions. Appendix D contains the data (traffic counts, photographs, and other site information) collected during noise measurements. Appendix E contains the TNM modeling runs for model verification.

4.2 Existing Noise Conditions

Table 3 shows the TNM® predicted noise results for the measured and modeled sites within the area studied for the existing noise condition (2013). The locations of all modeled sites can be seen on Figure 6. The modeled noise levels along the current roadways range from 59 dBA $L_{eq(h)}$ to 65 dBA $L_{eq(h)}$. Predicted existing noise levels were compared with the FHWA noise abatement criteria (NAC) (Table 1) and found to reach the ODOT NAAC of 65 dBA at five apartment units located at Franklin Boulevard and Seneca Avenue and a commercial golf park located on Franklin Boulevard at Concord Street. Appendix E contains the TNM modeling runs for the Existing Condition.

Outdoor use areas located nearest to Franklin Boulevard experience the loudest noise levels in the area. The modeled noise levels at these receivers are primarily influenced by the proximity of the receiver to the existing roadways, but are also influenced by the amount of physical shielding provided by nearby buildings, and topography.

Figure 6. Existing Noise Levels for Measured and Modeled Noise Receptor Sites

Source: Parsons Brinckerhoff, 2015

Table 3. Predicted Noise Levels for the Existing Condition

Noise Receiver Number	Number of Uses Represented by the Receiver	Land Use Criteria	Activity Category/ ODOT NAAC dBA $L_{eq(h)}$	Existing (2013) Traffic Noise Level dBA $L_{eq(h)}$	Exceeds ODOT NAAC (Yes/No)
M1	1	Commercial	E/70	65	No
M2	5	Residential	B/65	**65**	**Yes**
M3	4	Residential	B/65	61	No
M4	4	Residential	B/65	61	No
M5	4	Residential	B/65	61	No
M6	3	Residential	B/65	63	No
R1	1	Community/ Medical/ Institutional	C/65	64	No
R2	1	Commercial	E/70	63	No
R3	1	Residential	B/65	59	No
R4	1	Residential	B/65	60	No
R5	4	Residential	B/65	60	No
R6	6	Residential	B/65	61	No
R7	3	Residential	B/65	61	No
R8	1	Recreation/ Golf Course	C/65	**65**	**Yes**

Notes:
See Table 1 for information on the noise abatement approach criteria activity categories.

Chapter 5 Future Noise Levels and Impacts

5.1 Traffic Noise Analysis

5.1.1 No Build Alternative

Figure 7 shows the locations of the noise prediction sites within the area studied. As with the existing noise levels, the No Build (year 2035) future noise levels along the current Franklin Boulevard alignment would be dependent upon distance and shielding conditions present between the receiver and the nearby roadways. Noise levels for the No Build Alternative would increase over time due to increased traffic volumes on the roadway network in the area studied and Franklin Boulevard traffic shifting to the south and closer to residences located near the proposed alignment. Noise levels for the No Build Alternative are predicted to range from 60 dBA $L_{eq(h)}$ to 67 dBA $L_{eq(h)}$ at the 14 modeled sites. The future No Build noise levels would increase by approximately 1 to 2 dB over the existing noise levels, as summarized in Table 4. Noise levels are predicted to exceed the ODOT NAAC under the future No Build Alternative at the same five apartments and a golf park as in the existing conditions and the outdoor sitting area at Planned Parenthood.

Locations where noise levels are predicted to reach ODOT NAAC are represented by modeled sites M2, R1, and R8. Future No Build Alternative noise levels at Sites M2, R1, and R8 would increase by 1 to 2 dBA over existing conditions noise levels. Appendix E contains the TNM modeling runs for the No Build and the Future Build Alternatives.

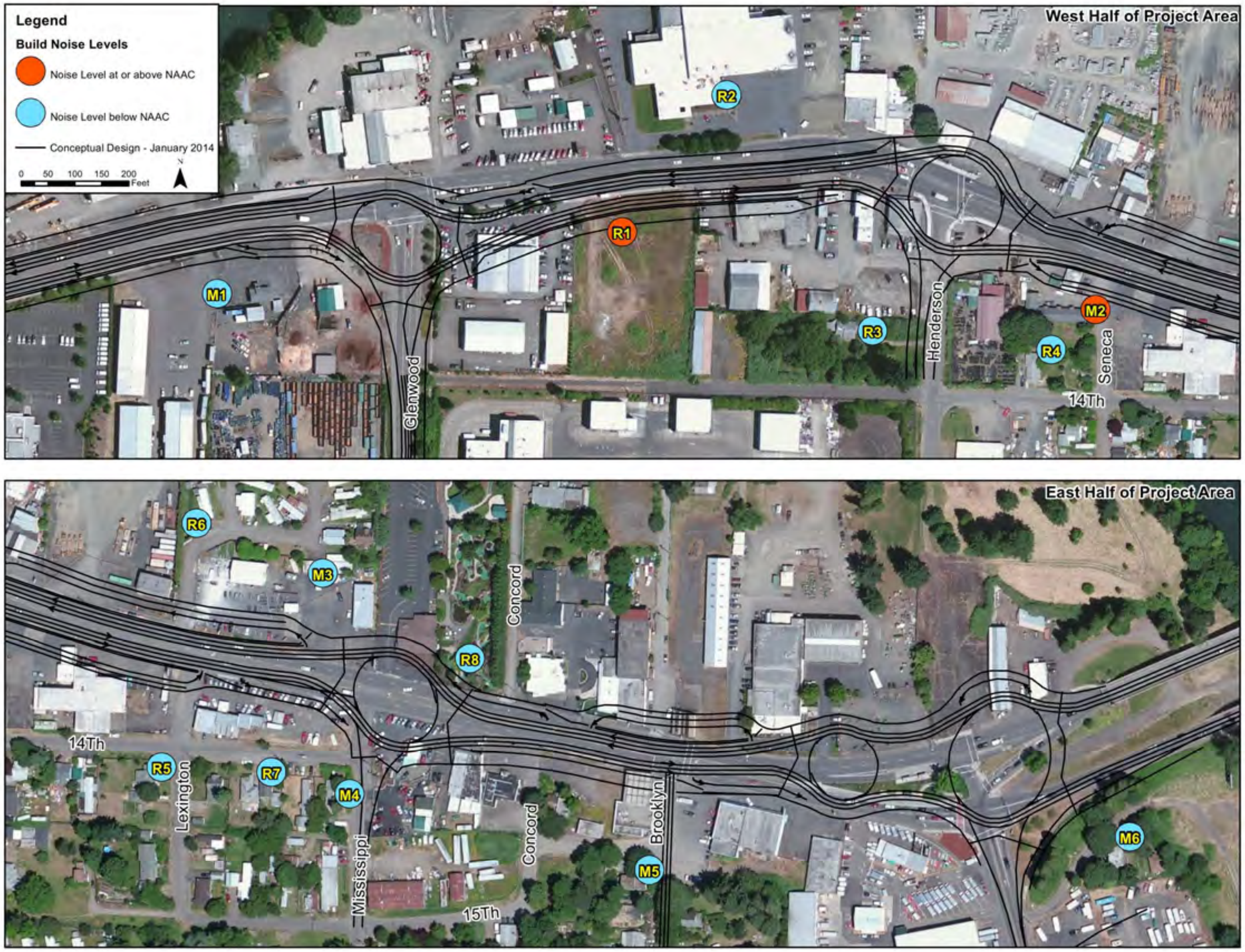
5.1.2 Build Alternative

Figure 8 shows the location of the noise prediction sites within the area studied. The Build Alternative (year 2035) noise levels along the proposed roadway improvements would be dependent upon distance and shielding conditions present. Noise levels for the Build Alternative would increase over time due to increased traffic volumes on Franklin Boulevard. Increases in traffic noise would also result from increased proximity to the proposed Franklin Boulevard alignment as the southward shift of Franklin Boulevard would move traffic noise closer to sensitive receivers located south of Franklin Boulevard. Noise levels for the Build Alternative would range from 61 dBA $L_{eq(h)}$ to 68 dBA $L_{eq(h)}$. The future Build Alternative noise levels would increase from 4 dB to decrease by 1 dB from existing conditions noise levels at modeled sites in the area (Table 4). These changes in noise levels are predicted to occur at properties closest to Franklin Boulevard. Decreases in noise levels result from reduced speeds of 25 mph at proposed roundabouts on Franklin Boulevard with the project. Increases in noise levels result from the project alignment moving closer to some noise sensitive locations. Future build noise levels reach the ODOT NAAC at the same five apartments and at the outdoor sitting area at Planned Parenthood. These properties are represented by Sites M2 and R1 are predicted to experience by 2 to 4 dBA increase over existing noise levels. The remaining modeled sites located near the project area are predicted to experience a -1 reduction to 2-dBA increase in noise levels compared to existing conditions which reflect each sites proximity from the existing alignment to the proposed alignment.

Figure 7. No Build Noise Levels for Measured and Modeled Noise Receptor Sites

Source: Parsons Brinckerhoff, 2015

Figure 8. Build Noise Levels for Measured and Modeled Noise Receptor Sites



Source: Parsons Brinckerhoff, 2015

Comparing Noise levels for the Build Alternative and No Build Alternative would be similar to the comparison of noise levels between the Build Alternative and existing conditions as noise levels are primarily influenced by the alignment of Franklin Boulevard. The noise levels for the Build Alternative are summarized in Table 4. As with the future No Build Alternative, five apartments and the outdoor sitting area at Planned Parenthood, (modeled sites M2, and R1), are the locations near Franklin Boulevard where future Build Alternative noise levels would meet the ODOT NAAC. Future Build Alternative noise levels at these two locations would increase by 2 to 4 dBA over existing conditions noise levels and would increase by 1 to 2 dBA with future No Build Alternative noise level of 65 or 66 dBA $L_{eq(h)}$ predicted at Sites M2 and R1.

5.2 Traffic Noise Impacts

As shown in Table 4, traffic noise levels under the Future Build (2035) meet or exceed the ODOT NAAC at two modeled receivers, sites M2 and R1, which represent five apartments and an outdoor sitting area at Planned Parenthood. Both sites all located near the proposed alignment changes on Franklin Boulevard. Future Build noise levels at the golf park, represented by Site R8 are predicted to decrease due to reduced speed at roundabout located along Franklin Boulevard with the project. No substantial increases of 10 dBA L_{eq} or greater were identified as a result of the proposed project.

Chapter 6 includes a discussion of mitigation measures evaluated to reduce noise levels at the two sites where impacts are predicted with the project.

Table 4. Predicted Traffic Noise Levels and No Build and Build Conditions

Noise Receiver Number	Number of Uses Represented by the Receiver	ODOT Criteria[1]/ NAAC	Existing 2013 Noise Level dBA $L_{eq(h)}$ (2010)	No Build Noise Level dBA $L_{eq(h)}$ (2035)	No Build 2035 Increase over Existing Noise Level dBA $L_{eq(h)}$	Build Noise Level dBA $L_{eq(h)}$(2035)	Build 2035 Increase over Existing Noise Level dBA $L_{eq(h)}$[2]	Number of Receptors with Impacts (2035 Build)
M1	1	E/70	65	67	2	67	2	0
M2	5	B/65	65	66	1	67	2	**5**
M3	4	B/65	61	63	2	62	1	0
M4	4	B/65	61	63	2	62	1	0
M5	4	B/65	61	62	1	62	1	0
M6	3	B/65	63	64	1	63	0	0
R1	1	C/65	64	66	2	68	4	**1**
R2	1	E/70	63	65	2	63	0	0
R3	1	B/65	59	60	1	61	2	0
R4	1	B/65	60	62	2	62	2	0
R5	4	B/65	60	61	1	62	2	0
R6	6	B/65	61	62	1	62	1	0
R7	3	B/65	61	63	2	62	1	0
R8	1	C/65	65	66	1	64	-1	0
Impact Totals			6	7		6		

Notes: [1] See __________ for information on the noise abatement criteria activity categories.
[2] A substantial increase is defined by ODOT as being an increase of 10 dBA $L_{eq\ (h)}$ or greater over the existing conditions.

Chapter 6 Mitigation

6.1 Findings

Noise abatement is necessary only where frequent human use occurs and where a lower noise level would provide benefits (FHWA 1982).

Any specific mitigation measure recommended as part of the project must be feasible and reasonable. For abatement to be feasible, ODOT requires that a simple majority of impacted receptors achieve at least a 5-dBA reduction in noise levels. ODOT also considers engineering factors such as barrier height, safety, topography, drainage, utilities, and access issues when determining feasibility. For abatement to be reasonable, ODOT must consider the viewpoints of the residents and property owners that benefit from the proposed abatement, the cost-effectiveness of the abatement measure, and the ODOT noise reduction design goal of the abatement measure providing at least a 7 dBA noise reduction at one benefited property.

Two sites, representing five apartments and an outdoor sitting area at Planned Parenthood located near the proposed Franklin Boulevard alignment, represented by Sites M2 and R1 (Table 4) are impacted by traffic noise by the Build Alternative (year 2035) conditions. Under the No Build Alternative (year 2035), these two sites and a third site are impacted by traffic noise. Possible mitigation measures are discussed below. Future Build Alternative noise levels at the five residences and outdoor use area would be within 2 dBA of existing conditions noise levels and would be within 1 dBA of future No Build Alternative noise levels of 65 or 66 dBA $L_{eq(h)}$ predicted at each site. Both locations are currently located in close proximity to vehicles traveling on Franklin Boulevard and will be located closer to Franklin Boulevard with the Build Alternative.

6.1.1 Noise Mitigation Considerations

The following noise mitigation options were considered to reduce noise levels at the two impacted sites.

Traffic management: control devices could be used to reduce the speed of the traffic; however, the minor benefit of one dBA per five mph reduction in speed does not outweigh the associated increase in congestion and air pollution. Other measures such as time or use restrictions for certain vehicles don’t meet the transportation objectives of the facility.

Alteration of horizontal and/or vertical alignments: any alteration of the existing alignment would displace additional businesses and displace residences, require additional right of way and not be cost effective/reasonable.

Buffer zone: the acquisition of undeveloped property to act as a buffer zone is designed to avoid rather than abate traffic noise impacts and, therefore, is not feasible.

Noise barriers include noise walls, berms, and buildings that are not sensitive to noise. A noise barrier’s effectiveness is determined by its height and length and by project site topography. To be effective, the barrier must block the line-of-sight between the noise source and the receptor. It must be long enough (at least eight times as long as the distance from the home or receptor to the barrier) to prevent sounds from passing around the ends, have no openings (i.e., driveway connections), and be dense enough so that noise would not be transmitted through it. Intervening rows of buildings that are not noise sensitive could also be used as barriers (FHWA 1973).

The impacted sites both have direct access to Franklin Boulevard by private driveways. The presence of these accesses prevents the construction of a wall long enough to reduce noise levels by 5 dBA or more which is the required feasibility criteria. Driveways, pedestrian paths or local road accesses create gaps in walls that prevent noise walls from achieving the minimum reduction in noise levels. The local roads also require sight distances for safety clearance that limit the length of noise walls placed adjacent to local roads.

Due to the proximity of both impacted sites to the existing and future roadway alignment and the lack of space required to provide adequate noise mitigation while maintaining access to each site, no mitigation measures were identified that would effectively reduce future peak hour traffic noise levels at the five apartments and the outdoor sitting area at Planned Parenthood represented by modeled Sites M2 and R1. No noise abatement is recommended for this project.

Chapter 7 Construction Noise Analysis

7.1 Temporary Construction Noise Impacts

If the Build Alternative were to be constructed, areas adjacent to the project would be exposed to construction noise. Although of a temporary nature, the additional noise can be annoying to the public.

Effects on adjacent communities during construction would include noise from the operation of construction equipment and noise from construction and delivery vehicles traveling to and from the construction site. The level of impact would depend on the noise characteristics of the equipment, activities involved, construction schedule, and distance of equipment from sensitive receptors.

At a typical noise receptor, the noise levels would be highest during the early phases of construction, when excavation and heavy daily truck traffic would occur. Average noise levels for typical construction equipment, measured at 50 feet from the construction site, range from 81 dBA for generators and pumps to 89 dBA for asphalt spreaders. The total hourly energy average dBA noise level, $L_{eq(h)}$, at a distance of 50 feet from the construction activity is usually approximately 85 dBA.

Estimates of maximum noise levels (L_{max}) at a distance of 50 feet for various pieces of construction equipment used on highway projects are provided in Table 5. The L_{max} represents the loudest monitored noise level from a specific piece of construction equipment whereas the $L_{eq(h)}$ is the average sound level of all construction equipment over a period of time, in this case one hour. While actual noise levels would vary due to particular equipment, phase of construction, and the influence of the person using the equipment, every effort should be made to minimize the adverse effects of construction noise whenever possible. Given the circumstances, the City of Springfield or Lane County may grant variances that would allow certain construction activities during after-hour periods or during weekends.

Construction noise is typically regulated on a project-specific basis in the form of Standard Specifications or Special Provisions in the contractor’s documents. The City of Springfield regulates noise from any mechanical device through the city’s municipal noise code, Chapter 5.220 Noise. Lane County limits sounds that exceed 10 dBA between the hours of 10:00 PM to 7:00 AM or 12 dBA between the hours of 6:00 PM to 10:00 PM over the ambient noise level within the sound sensitive unit with a window ajar and measured from no closer than 3 feet from the window. Lane County allows for exceptions to these rules which may apply to sound created by construction activities and for vehicle traffic on public roads.

Table 5. Construction Equipment Noise Levels

Equipment Description	Impact Device (Yes/No)[1]	Acoustic Usage Factor (%)[2]	Specified Limit dBA L_{max} @ 50 feet[3]	Actual Measured dBA L_{max} @ 50 feet[4]
All other equipment > 5 HP	No	50	85	N/A
Auger drill rig	No	20	85	84
Backhoe	No	40	80	78
Bar bender	No	20	80	N/A
Blasting	Yes	N/A	94	N/A
Boring jack power unit	No	50	80	83
Chain saw	No	50	85	84
Clam shovel (dropping)	Yes	20	93	87
Compactor (ground)	No	20	80	83
Compressor (air)	No	40	80	78
Concrete batch plant	No	15	83	N/A
Concrete mixer truck	No	40	85	79
Concrete pump truck	No	20	82	81
Concrete saw	No	20	90	90
Crane	No	16	85	81
Dozer	No	40	85	82
Drill rig truck	No	20	84	79
Drum mixer	No	50	80	80
Dump truck	No	40	84	76
Excavator	No	40	85	81
Flat bed truck	No	40	84	74
Front end loader	No	40	80	79
Generator	No	50	82	81
Generator (<25 KVA, VMS signs)	No	50	70	73
Gradall	No	40	85	83
Grader	No	40	85	83
Grapple (on backhoe)	No	40	85	87
Horizontal boring hydraulic jack	No	25	80	82
Hydra break ram	Yes	10	90	N/A
Impact pile driver	Yes	20	95	101
Jackhammer	Yes	20	85	89
Man lift	No	20	85	75
Mounted impact hammer (hoe ram)	Yes	20	90	90
Pavement scarafier	No	20	85	90
Paver	No	50	85	77

Table 5. Construction Equipment Noise Levels (Cont.d)

Equipment Description	Impact Device (Yes/No)[1]	Acoustic Usage Factor (%)[2]	Specified Limit dBA L_{max} @ 50 feet[3]	Actual Measured dBA L_{max} @ 50 feet[4]
Pickup truck	No	40	55	75
Pneumatic tools	No	50	85	85
Pumps	No	50	77	81
Refrigerator Unit	No	100	82	73
Rivet buster/chipping gun	Yes	20	85	79
Rock drill	No	20	85	81
Roller	No	20	85	80
Sand blasting (single nozzle)	No	20	85	96
Scraper	No	40	85	84
Shears (on Backhoe)	No	40	85	96
Slurry plant	No	100	78	78
Soil mix drill rig	No	50	80	N/A
Tractor	No	40	84	N/A
Vacuum excavator (Vac-truck)	No	40	85	85
Vacuum street sweeper	No	10	80	82
Ventilation fan	No	100	85	79
Vibrating hopper	No	50	85	79
Vibratory concrete mixer	No	20	80	80
Vibratory pile driver	No	20	95	101
Warning horn	No	5	85	83
Welder/torch	No	40	73	74

Source: USDOT, FHWA 2006

Notes:
[1] An indication as to whether or not the equipment is an impact device.
[2] The acoustical usage factor to assume for modeling purposes.
[3] The specification "spec" limit for each piece of equipment expressed as an L_{max} level in dBA at a reference distance of 50 feet.
[4] The measured "ACTUAL" noise level at 50 feet for each piece of equipment.

7.2 Construction Noise Abatement

The following measures, many of which are included in Section 290.32 of ODOT standard specifications could be taken to the extent practicable to avoid, minimize, and mitigate temporary adverse noise impacts:

- The contractor shall comply with all state and local sound control and noise level rules, regulations, and ordinances that would apply to any work performed pursuant to the contract.
- The contractor must provide a detailed construction noise control plan, which would list all of the proposed construction equipment and types of construction activity.

- All equipment shall comply with pertinent equipment noise standards of the EPA.
- All equipment used shall have sound control devices no less effective than those provided on the original equipment. No equipment shall have unmuffled exhaust.
- All equipment shall comply with the pertinent equipment noise standards found in the FHWA Roadway Construction Noise Model as shown in Table 5.
- No construction shall be performed within 1,000 feet of an occupied dwelling unit on weekends, legal holidays, and between the hours of 10:00 p.m. and 7:00 a.m. on other days without the approval of ODOT’s Project Manager.
- No pile driving, hoe ramming, or blasting operations shall be performed within 3,000 feet of any occupied dwelling unit on weekends, legal holidays, and between the hours of 10:00 p.m. and 7:00 a.m. on other days without the approval of ODOT’s Project Manager.
- The noise from rock crushing or screening operations within 3,000 feet of any occupied dwelling shall be mitigated by strategic placement of material stockpiles between the operation and the affected dwelling or by other means approved by ODOT’s Project Manager.

Should specific noise complaints occur during the construction of the project, one or more of the following noise abatement measures may be required at the Contractor’s expense, as directed by ODOT’s Project Manager:

- Locate stationary construction equipment as far from the nearby noise-sensitive properties as possible.
- Shut off idling equipment.
- Use alternative methods or equipment which produces less noise.
- Reschedule construction operations to avoid periods of noise annoyance identified in the complaint.
- Notify nearby residences whenever extremely noisy work will be occurring.
- Install temporary or portable acoustic barriers around stationary construction noise sources.
- Operate electric-powered equipment using line voltage power instead of on-site generators.

Use manually-adjustable or new broadband backup alarms which can be localized and focused to the danger zone and set to the low noise setting on all construction vehicles used during nighttime hours.

Chapter 8 Information for Local Government Officials

A copy of this report will be made available to the City of Springfield Community Planning Department by ODOT. This report will serve to inform the City of the effects of the highway and highway-construction-related noise in the area studied. The information contained within this report can assist the City in its planning process. It is recommended that the City use this information as a guide when developing future land use plans, zoning, or building code requirements. The use of this information may assist local government with future development plans and thereby result in development that is consistent with the noise environment.

At the time of this report, undeveloped or vacant lots are located to the north and south of the proposed Franklin Boulevard Project alignment. According to the ODOT Noise Manual, if building permits have been submitted for the undeveloped properties, the proposed development needs to be included in the noise study. As of April 1, 2015, no building permits were on file with the City of Springfield's Public Works Department with the intent to develop structures such as residences, commercial uses, or other NAAC B, C, D, or F at the undeveloped properties along the corridor.

Based on the results of this report and future traffic volumes and speeds included in this report, areas within 90 feet of Franklin Boulevard may experience noise levels up to the ODOT NAAC of 65 dBA for residential land use and other outdoor land uses such as playfields and parks. Commercial and related business uses located within 15 feet of Franklin Boulevard may experience noise levels up to the ODOT NAAC of 70 dBA for hotels, offices, and similar uses such as restaurants and bars.

Chapter 9 References

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Appendix A—ODOT Project Type Determination Memorandum

Appendix A presents a memorandum prepared by Parsons Brinckerhoff on April 16, 2014 to document ODOT Project Type determination for the Franklin Boulevard Project.

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Memorandum

Date: April 16, 2014

To: Kristi Krueger, Principal Civil Engineer, Community Development Division, Development and Public Works Department, City of Springfield

From: Patrick Romero, Lead Environmental Planner, Parsons Brinckerhoff

Subject: ODOT Project Type Determination (for Noise), Franklin Boulevard Design Refinement and Environmental Classification Project

INTRODUCTION

This technical memorandum documents the determination of Oregon Department of Transportation (ODOT) Project Type for the Franklin Boulevard Project. The ODOT Noise Manual defines roadway projects into three project types that correspond to the level of noise analysis required for a project.[1] Once the project type has been determined the required level of analysis can be performed. This memorandum also documents coordination with ODOT Noise Program Staff to determine ODOT Project Type.

PROJECT DESCRIPTION

The proposed roadway improvements included in the Franklin Boulevard Project would result in a wider cross-section for Franklin Boulevard between a location 1/4-mile east of I-5 and McVay Highway. The existing width varies between 70 and 75 feet. From Glenwood Boulevard to Henderson Avenue, Franklin Boulevard's cross-section would be expanded to 128 feet; between Henderson Avenue and Mississippi Avenue, Franklin Boulevard's cross-section would be expanded to 175 feet; and between Mississippi Avenue and McVay Highway, Franklin Boulevard's cross-section would be expanded to 155 feet. The centerline of the new right-of-way cross-section would be placed approximately at the centerline of the existing right-of-way. Figure 1 provides a summarized view of Project improvements.

Four new roundabouts on Franklin Boulevard at Glenwood Boulevard, Henderson Avenue, Mississippi Avenue, and McVay Highway would connect the new alignment cross-sections. The roundabouts would include connections to existing streets intersecting Franklin Boulevard and provide connections to future planned roads as described in the Glenwood Refinement Plan.[2] The design provides bus rapid transit stations with pull-outs at three of the roundabouts. The cross sections and diameters of the roundabouts (and their footprints) have been determined at a conceptual level and the eastern roundabout is a dual or "dog bone" roundabout.[3] Additional Project elements include medians, through lanes, bike lanes, planter strips, parking and access to parking, and sidewalks.

ODOT PROJECT TYPE DEFINITIONS

The following lists ODOT Project Type definitions provided in the ODOT Noise Manual.

Type I Project: A Type I project can include the following projects:

- The construction of a highway on new location;
- The physical alteration of an existing highway where there is either a substantial horizontal or vertical alteration;[4]

[1] ODOT. 2011. ODOT Noise Manual. Pages 4-5.
[2] City of Springfield. 2009. Glenwood Refinement Plan Update Project.
[3] URS. 2013. Franklin Boulevard: I-5 Bridge to McVay Highway Project Strategic Overview.
[4] ODOT. 2011. ODOT Noise Manual. Page 4.

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- The addition of a through-traffic lane(s), including the addition of a through-traffic lane that functions as High-Occupancy lane, High-Occupancy Toll (HOT) lane, bus lane, or truck climbing lane;
- The addition of an auxiliary lane, except when the auxiliary lane is a turn lane;
- The addition or relocation of interchange lanes or ramps added to a quadrant to complete an existing partial interchange;
- Restriping existing pavement for the purpose of adding a through-traffic lane or an auxiliary lane; and
- The addition of a new or substantial alteration of a weight station, rest area, ride-share lot, or toll plaza.

If a project is determined to be a Type I project, then the entire project area as defined in the environmental document is a Type I project.

Type II Project: Oregon does not have an FHWA-approved Type II program. State and local funding may be provided in response to noise complaints through ODOT's non-federally funded Retrofit Program.

Type III Project: A federally or federal-aid highway project that does not meet the classification of a Type I or Type II project. Type III projects do not require a noise analysis.

REVIEW AND AGENCY COORDINATION

Parsons Brinckerhoff reviewed the Revised Conception Design for the Franklin Boulevard Project dated January 24, 2014.[5] The Revised Conceptual Design was compared to project elements defined in the ODOT Noise Manual for Project Types I, II, and III. In emails and telephone conversations on January 30, and February 11 and 12, 2014, Parsons Brinckerhoff's noise specialist (Patrick Romero), ODOT Noise Program Coordinator Carole Newvine, and ODOT Air and Noise Specialist Natalie Liljenwall discussed the Franklin Boulevard Project elements and ODOT Project Type definitions.

Through agency coordination and the review of project elements included in the Project, ODOT concluded that the Franklin Boulevard Project met the definition of a Type I Project and thus, a noise analysis is required for the project. ODOT's determination focused on the project's plan to remove several buildings located on Franklin Boulevard that would open the line-of-sight to traffic at residences located behind buildings planned for demolition. While through-traffic lanes would shift traffic closer to nearby residences and potentially increase traffic noise levels, the vertical distance from the new roadway to the closest noise sensitive receptor would not be defined as significant[6]. The trigger for a noise study determination is the "substantial vertical alteration" that ODOT defines as, "...shielding has been removed, therefore exposing the line-of-sight between the receptor and the traffic noise source." As detailed in 23 CFR 772 (Federal Procedures for Abatement of Highway Traffic Noise and Construction Noise), removing existing noise shielding requires a noise study.[7]

[5] URS. 2014. Franklin Blvd Project Revised Conceptual Plan.
[6] ODOT. 2011. ODOT Noise Manual, *Definitions*
[7] U.S. Department of Transportation Federal Highway Administration. 1997. CFR Title 23, Part 772.

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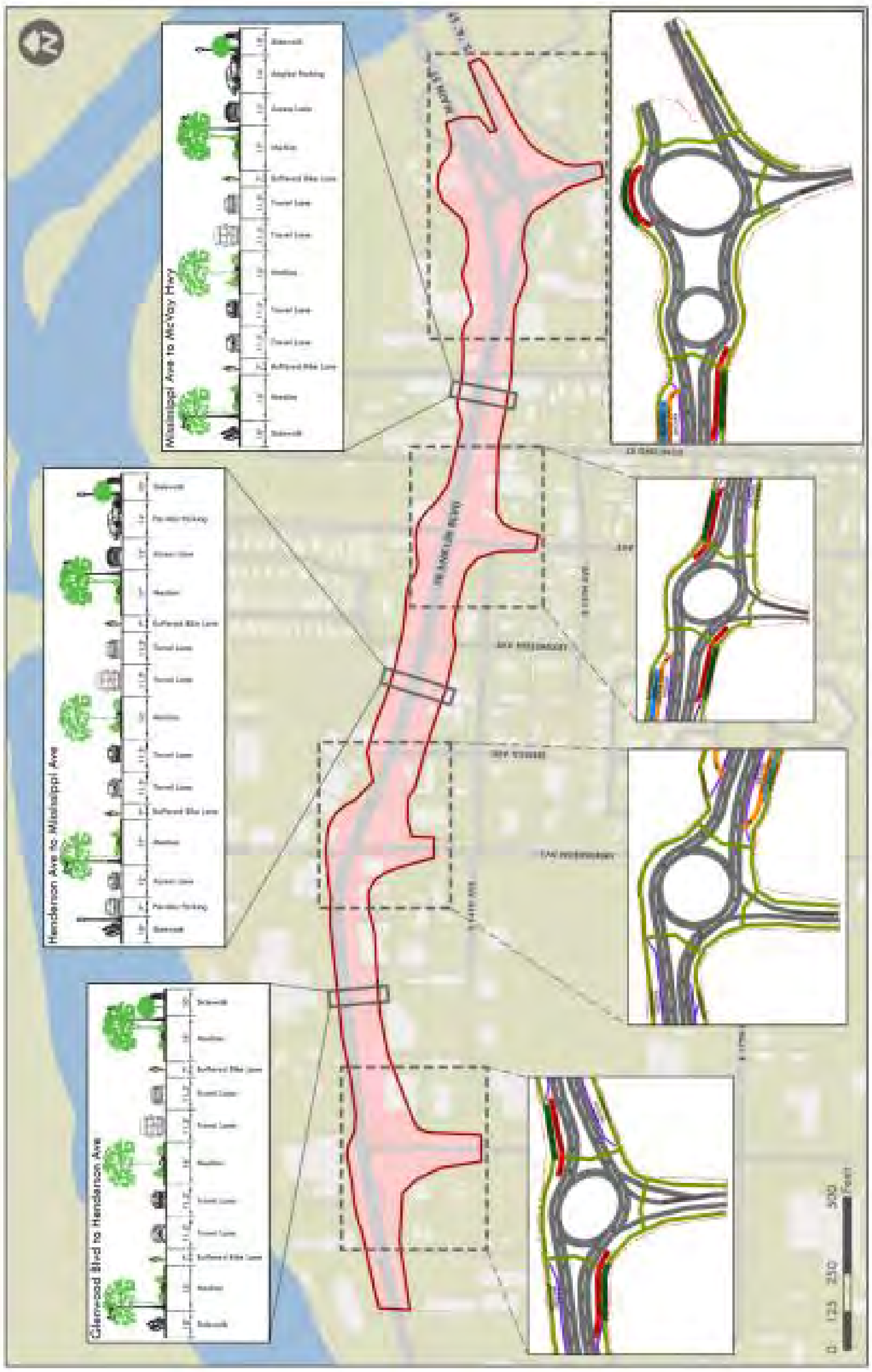
Figure 1 Franklin Boulevard Project



Appendix B—Introduction to Acoustics

Sound is created when objects vibrate, resulting in a minute variation in surrounding atmospheric pressure called sound pressure. The human response to sound depends on the magnitude of a sound as a function of its frequency and time pattern (EPA 1974). Magnitude measures the physical sound energy in the air. The range of magnitude, from the faintest to the loudest sound the ear can hear, is very large so, for convenience, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Loudness, compared with physical sound measurement, refers to how people subjectively judge a sound. This varies from person to person. Table B-1 shows the magnitudes of typical noise sources.

Table B-1. Typical Noise Levels

Transportation Sources	Sound Level (dBA)	Other Sources	Description
	130		Painfully loud
Jet takeoff (200 feet)	120		
Car horn (3 feet)	110		Maximum vocal effort
	100	Shout (0.5 feet)	
	95		Very annoying
Heavy truck (50 feet)	90	Jack hammer (50 feet)	Loss of hearing with prolonged exposure
		Home shop tools (3 feet)	
Train on a structure (50 feet)	85	Backhoe (50 feet)	
City bus (50 feet)	80	Bulldozer (50 feet)	Annoying
		Vacuum cleaner (3 feet)	
Train (50 feet)	75	Blender (3 feet)	
City bus at stop (50 feet)			
Freeway traffic (50 feet)	70	Lawn mower (50 feet)	
		Large office	
Train in station (50 feet)	65	Washing machine (3 feet)	Intrusive
	60	TV (10 feet)	
Light traffic (50 feet)	55	Talking (10 feet)	
Light traffic (100 feet)	50		Quiet
	45	Refrigerator (3 feet)	
	40	Library	
	30	Soft whisper (15 feet)	Very quiet

Sources: USDOT (1995); EPA (1971, 1974).

Humans respond to a sound's frequency or pitch. The human ear can very effectively perceive sounds with a frequency between approximately 500 and 5,000 Hz, but the efficiency decreases outside this range. Environmental noise is composed of many frequencies, each occurring simultaneously at its own sound pressure level. Frequency weighting, which is applied electronically by a sound level meter, combines the overall sound spectrum into one sound level that simulates how a typical person hears sounds. The commonly used frequency weighting for environmental noise is A-weighting (dBA), which is most similar to how humans perceive sounds of low to moderate magnitude.

Because of the logarithmic decibel scale, a doubling of the number of sound sources (such as the number of cars operating on a roadway) increases noise levels by 3 dBA. A ten-fold increase in the number of sound sources would add 10 dBA. As a result, a sound source emitting a sound level of 60 dBA combined with another sound source of 60 dBA yields a combined sound level of 63 dBA, not 120 dBA. The human ear can barely perceive a 3-dBA increase, but a 5- or 6-dBA increase is readily noticeable and appears as if the sound is about one and one-half times as loud. A 10-dBA increase appears to be a doubling in sound level to most listeners.

Noise levels from traffic sources depend on traffic volume, vehicle speed, type of vehicle, and pavement surface conditions. Generally, an increase in traffic volume, speed, or vehicle size increases traffic noise levels. Vehicular noise is a combination of noises from the engine, exhaust, and tires. Other conditions affecting the propagation of traffic noise include defective mufflers, steep grades, terrain, vegetation, distance from the roadway, and shielding by barriers and buildings.

Sound levels decrease with distance from the source. For a line source, such as a roadway, sound levels decrease 3 dBA over hard ground (concrete, pavement) or 4.5 dBA over soft ground (grass) for every doubling of distance between the source and the receptor. For a point source, such as construction sources, sound levels would decrease between 6 and 7.5 dBA for every doubling of distance from the source.

The propagation of sound can be greatly affected by terrain and the elevation of the receptor relative to the sound source. Level ground is the simplest scenario: sound travels in a straight line-of-sight path between the source and receptor. If the sound source is depressed or the receptor is elevated, sound generally travels directly to the receptor. Sound levels may be reduced because the terrain crests between the source and receptor, resulting in a partial sound barrier near the receptor. If the sound source is elevated or the receptor is depressed, sound often is reduced at the receptor. The edge of the roadway can act as a partial sound barrier, blocking some sound transmission between the source and receptor.

Even a short barrier, such as a solid concrete jersey-type safety barrier, can be effective at further reducing traffic noise levels. However, to be truly effective, a noise barrier must break the line-of-sight between a noise source and the listener. Breaking the line-of-sight between the receptor and the highest sound source typically results in a noise reduction of approximately 5 dBA. Noise levels can be reduced by as much as 15 dBA with a well-designed and properly constructed noise barrier.

Sound Level Descriptors

A widely used descriptor for environmental noise is the equivalent sound level (L_{eq}). The L_{eq} can be considered a measure of the average sound energy during a specified period of time. L_{eq} is defined as the constant level that, over a given period of time, transmits to the receptor the same amount of acoustical energy as the actual time-varying sound. For example, two sounds, one of which contains twice as much energy but lasts only half as long, have the same L_{eq} sound levels. L_{eq} measured over a one-hour period is the hourly L_{eq} [$L_{eq(h)}$], which is used for highway noise impact and abatement analyses.

Short-term sound levels, such as those from a single truck passing by, can be described by either the total sound energy or the highest instantaneous sound level that occurs during the event. The sound exposure level (SEL) is a measure of total sound energy from an event and is useful in determining what the L_{eq} would be over a period of time when several sound events occur. The maximum sound level ($L_{max)}$ is the greatest short-duration sound level that occurs during a single event. L_{max} is related to impacts on speech interference and sleep disruption. In comparison, L_{min} is the minimum sound level during a period of time.

People generally find a moderately high, constant sound level more tolerable than a quiet background level interrupted by frequent high-level noise intrusions. An individual's response to sound depends greatly on the range that the sound varies in a given environment. For example, steady traffic noise from a highway is normally less bothersome than occasional aircraft flyovers in a relatively quiet area. In light of this subjective response, it is often useful to look at a statistical distribution of sound levels over a given time period in addition to the average sound level. Such distributions identify the sound level exceeded and the percentage of time exceeded. It therefore allows for a more thorough description of the range of sound levels during the given measurement period. These distributions are identified with an L_n where n is the percentage of time that the levels are exceeded. For example, the L_{10} level is the noise level that is exceeded 10 percent of the time.

Effects of Noise

Environmental noise at high intensities directly affects human health by causing the disease of hearing loss. Prolonged exposure to very high levels of environmental noise can cause hearing loss. The EPA has established a protective level of 70 dBA L_{eq} (24), below which hearing is conserved for exposure over a 40-year period (EPA 1974). Although scientific evidence is not currently conclusive, noise is suspected of causing or aggravating other diseases. Environmental noise indirectly affects human welfare by interfering with sleep, thought, and conversation. The FHWA noise abatement criteria are based on speech interference, which is a well-documented impact that is relatively reproducible in human response studies. Noise also can affect wildlife.

Appendix C—Traffic Data

For this noise study, traffic volume data was provided by the City of Springfield for the existing conditions 2013, No Build Alternative 2035, and Build Alternative 2035 worst hourly condition (Table C-1). The TNM® model uses three categories of traffic vehicles, namely automobiles, medium trucks, and heavy trucks. Automobiles are defined as vehicles with two axles and four wheels, including pickup trucks, SUVs, and vans. Medium trucks have two axles with six wheels and include most buses. Heavy trucks are defined as vehicles having more than two axles.

Table C-2 provides a comparison on peak hour and truck peak hour traffic volumes and modeled noise levels. Peak Hour Traffic Volumes were used in the analysis as Peak Truck Hour Traffic Noise Levels were lower than Peak Hour Traffic Noise Levels.

Table C-1. Modeled Traffic Volumes

Roadway	Direction of Travel	Speeds[1] (mph)	Existing Conditions, 2013 (PM Peak Hour)				No Build and Build Alternatives, 2035 (PM Peak Hour)			
			Total	Auto-mobiles	Medium Trucks	Heavy Trucks	Total	Auto-mobiles	Medium Trucks	Heavy Trucks
EB – Start Glenwood Blvd	Eastbound	35	827	794	8	25	1270	1219	13	38
EB – Glenwood Blvd to Henderson	Eastbound	35	888	852	9	27	1185	1137	12	36
EB – Henderson to OR225	Eastbound	35	888	852	9	27	1132	1087	11	34
EB – OR225 to End	Eastbound	35	931	894	9	28	1199	1151	12	36
WB – End to OR225	Westbound	35	1088	1044	11	33	1524	1463	15	46
WB – OR225 to Henderson	Westbound	35	676	649	7	20	1000	960	10	30
WB – Henderson to Glenwood	Westbound	35	688	660	7	21	1081	1038	11	32
WB – Glenwood to Start	Westbound	35	695	667	7	21	1202	1154	12	36

Source: City of Springfield, 2014.

[1] 25mph was the modeled speed for the 2035 Build Alternative for all modeled roadways.

Table C-2. Peak Hour and Peak Truck Hour Traffic Volume Comparison for the 2035 No Build Alternative

Primary Roadways / Direction	Peak Hour No Build Alternative, 2035[1]				Peak Truck Hour No Build Alternative, 2035[1]			
	Auto-mobiles	Medium Trucks	Heavy Trucks	Noise Level Range at Modeled Receiver	Auto-mobiles	Medium Trucks	Heavy Trucks	Noise Level Range at Modeled Receiver
EB – Start Glenwood Blvd	1219	13	38	60 – 66 dBA L_{eq}	513	5	16	58 – 65 dBA L_{eq}
EB – Glenwood Blvd to Henderson	1137	12	36		621	6	19	
EB – Henderson to OR225	1087	11	34		619	6	19	
EB – OR225 to End	1151	12	36		564	6	18	
WB – End to OR225	1463	15	46		1238	13	39	
WB – OR225 to Henderson	960	10	30		743	8	23	
WB – Henderson to Glenwood	1038	11	32		714	7	22	
WB – Glenwood to Start	1154	12	36		712	7	22	

Source: Parsons Brinckerhoff, 2013

[1] The Peak Hour and Peak Truck Hour Traffic Noise Levels are provided electronically and entitled, *Franklin_NoBld* and *PeakTruckNoBld*.

Appendix D—Noise Measurement Data and Photographs

This appendix includes field data sheets and photos of noise measurements conducted on November 10, 2014. The measurements were performed at residential outdoor use areas or areas adjacent to outdoor use areas to validate the noise model.

Measurement Sites M1—Field Data Sheet

FIELD MEASUREMENT DATA SHEET

PB

Project Name: Franklin Blvd Job # 80457E

SITE IDENTIFICATION: M1 OBSERVER(s): Landro
START DATE & TIME: 11/10/14 12:00 AEND DATE & TIME: 11/10/14 12:30
ADDRESS: 3403 Franklin Blvd (Adj to)

GPS coordinates:

ID

TEMP: 50 °F HUMIDITY: 60 % R.H. WIND: CALM LIGHT MODERATE VARIABLE
WINDSPEED: 0-4 MPH DIR: N NE E SE S SW W NW STEADY GUSTY ___ MPH
SKY: CLEAR SUNNY DARK PARTLY CLOUDY OVRCST FOG DRIZZLE RAIN Other:

Weather

INSTRUMENT: LD 820 SLM Mic 2560 TYPE: 1 2 SERIAL #: 1813 1967 2979
CALIBRATOR: LD CAL 200 SERIAL #: 2239
CALIBRATION CHECK: PRE-TEST 114.0 dBA SPL POST-TEST 114.0 dBA SPL WINDSCREEN Yes
SETTINGS: A-WEIGHTED SLOW FAST FRONTAL RANDOM ANSI OTHER:

Rec # / Start Time / End Time
M1 / 12:15 / 12:30 : L_{eq} 69.0, L_{max} 83.2, L_{min} 57.4, L_{90} 61.6, L_{50} 67.1, L_{10} 71.4, L(1) 73.2
___ / ___ / ___ : L_{eq} ___, L_{max} ___, L_{min} ___, L_{90} ___, L_{50} ___, L_{10} ___, ___
___ / ___ / ___ : L_{eq} ___, L_{max} ___, L_{min} ___, L_{90} ___, L_{50} ___, L_{10} ___, ___
___ / ___ / ___ : L_{eq} ___, L_{max} ___, L_{min} ___, L_{90} ___, L_{50} ___, L_{10} ___, ___

COMMENTS:

Acoustic Measurements

PRIMARY NOISE(S): TRAFFIC AIRCRAFT RAIL INDUSTRIAL AMBIENT OTHER
ROADWAY TYPE: Franklin Blvd

COUNT DURATION: 10 -MINUTE

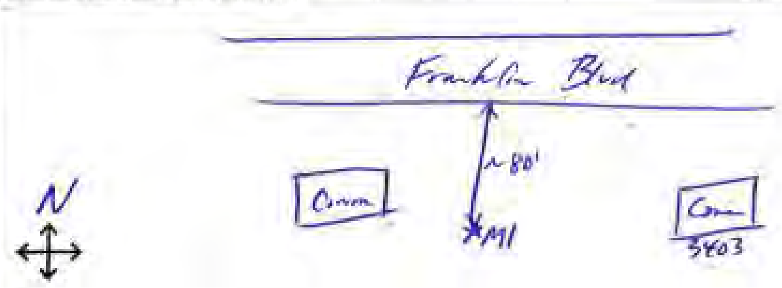
	NB / EB / SB / WB	SPEED (mph) NB EB / SB WB	#2 COUNT: NB / EB / SB / WB	SPEED (mph) NB EB / SB WB
AUTOS:	146 / 128	40 / 40	X	X
MED. TRUCKS:	2 / 2	↓ / ↓	X	X
HVY TRUCKS:	2 / 4	↓ / ↓	X	X
BUSES:	/	/	/	/
MOTORCYCLES:	/	/	/	/

SPEED ESTIMATED BY: RADAR / DRIVING / OBSERVER

OTHER NOISE SOURCES: distant AIRCRAFT overhead / RUSTLING LEAVES / distant BARKING DOGS / BIRDS
distant CHILDREN PLAYING / distant TRAFFIC / distant LANDSCAPING / distant TRAINS
OTHER: Traffic Speed Revised from 35mph to 40mph after error was made recording field form.

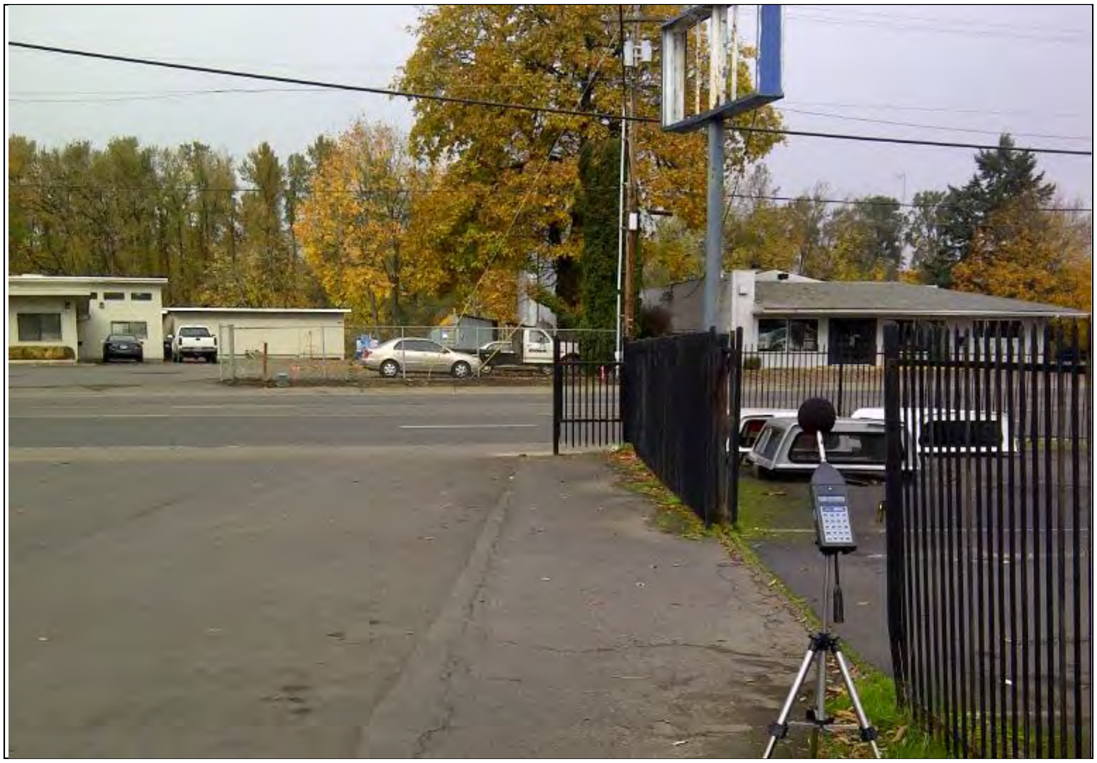
Source Info and Traffic Counts

TERRAIN: HARD SOFT MIXED FLAT OTHER:
PHOTOS: Digital
OTHER COMMENTS / SKETCH:



Description / Sketch

Measurement Site M1—View to North



Measurement Site M1—View to South

Measurement Sites M2—Field Data Sheet

FIELD MEASUREMENT DATA SHEET

PB

Project Name: Franklin Blvd   Job # B0457E

SITE IDENTIFICATION: M2   OBSERVER(s): Romero
START DATE & TIME: 11/10/14 4:30   END DATE & TIME: 11/10/14 4:45
ADDRESS: 3787 Franklin Blvd at Seneca St

GPS coordinates:

ID

TEMP: 54 °F   HUMIDITY: 60 % R.H.   WIND: CALM LIGHT MODERATE VARIABLE
WINDSPEED: 0-2 MPH   DIR: N NE E SE S SW W NW   STEADY GUSTY ___ MPH
SKY: CLEAR SUNNY DARK PARTLY CLOUDY OVRCST FOG DRIZZLE RAIN Other: ___

Weather

INSTRUMENT: LD 820 SLM 828, 2560 (Prem mic)   TYPE: 1 2   SERIAL #: 1373, 1967, 2979
CALIBRATOR: LD CAL 200   SERIAL #: 2239
CALIBRATION CHECK: PRE-TEST 114.0 dBA SPL   POST-TEST 114.0 dBA SPL   WINDSCREEN Yes

SETTINGS: A-WEIGHTED SLOW FAST FRONTAL RANDOM ANSI OTHER: ___

Rec #	Start Time / End Time	L_{eq}	L_{max}	L_{min}	L_{90}	L_{50}	L_{10}	
M2	4:30 / 4:45	63.7	74.3	51.1	55.1	62.7	67.1	L(1) 69.6
	/							
	/							
	/							

COMMENTS:

Acoustic Measurements

PRIMARY NOISE(S): TRAFFIC AIRCRAFT RAIL INDUSTRIAL AMBIENT OTHER
ROADWAY TYPE: Franklin Blvd

COUNT DURATION: 10 -MINUTE

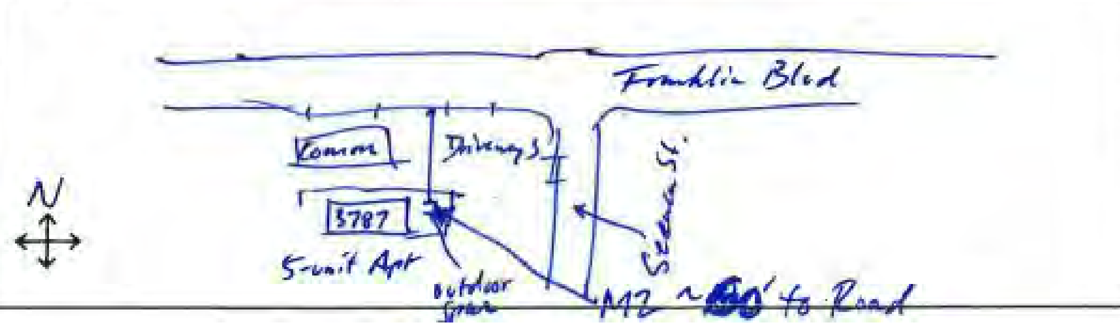
	NB / EB / SB / WB	SPEED (mph) NB EB / SB WB	#2 COUNT: NB / EB / SB / WB	#2 SPEED (mph) NB EB / SB WB
AUTOS:	78 / 108	40 / 40	/	/
MED. TRUCKS:	2 / 2	↓ / ↓	/	/
HVY TRUCKS:	8 / 8	/	/	/
BUSES:	/	/	/	/
MOTORCYCLES:	/	/	/	/

SPEED ESTIMATED BY: RADAR / DRIVING / OBSERVED

OTHER NOISE SOURCES: distant AIRCRAFT overhead / RUSTLING LEAVES / distant BARKING DOGS / BIRDS
distant CHILDREN PLAYING / distant TRAFFIC / distant LANDSCAPING / distant TRAINS
OTHER:

Source Info and Traffic Counts

TERRAIN: HARD SOFT MIXED FLAT OTHER:
PHOTOS: Digital
OTHER COMMENTS / SKETCH:



Description / Sketch

Measurement Site M2—View to North

Measurement Site M2—View to South

Measurement Sites M3—Field Data Sheet

FIELD MEASUREMENT DATA SHEET

PB

Project Name: Franklin Blvd   Job # B0457E

ID

SITE IDENTIFICATION: M3   OBSERVER(s): Romero

START DATE & TIME: 11/10/14 1:50   END DATE & TIME: 11/10/14 2:15

ADDRESS: 3998 Franklin (at Ponderosa Village Mobile Home Park)

GPS coordinates:

Weather

TEMP: 51 °F   HUMIDITY: 60 % R.H.   WIND: CALM (LIGHT) MODERATE VARIABLE

WINDSPEED: ____ MPH   DIR: N NE E SE S SW W NW   STEADY GUSTY ____ MPH

SKY: CLEAR SUNNY DARK PARTLY CLOUDY (OVRCST) FOG DRIZZLE RAIN Other:

Acoustic Measurements

INSTRUMENT: LD 820 SLM, (Prm mic) 828, 2560   TYPE: (1) 2   SERIAL #: 1313, 1967, 2979

CALIBRATOR: LD CAL 200   SERIAL #: 2239

CALIBRATION CHECK: PRE-TEST 114.0 dBA SPL   POST-TEST 114.0 dBA SPL   WINDSCREEN Yes

SETTINGS: A-WEIGHTED SLOW FAST FRONTAL RANDOM ANSI OTHER:

Rec #	Start Time	End Time	L_{eq}	L_{max}	L_{min}	L_{90}	L_{50}	L_{10}	
M31	1:55	2:10	57.7	65.5	48.9	50.8	55.7	61.3	L(1) 64.2

COMMENTS:

Source Info and Traffic Counts

PRIMARY NOISE(S): (TRAFFIC) AIRCRAFT RAIL INDUSTRIAL AMBIENT OTHER

ROADWAY TYPE: Franklin Blvd

COUNT DURATION: 10 -MINUTE

	NB / (EB) / SB / (WB)	SPEED (mph) NB (EB) / SB (WB)	#2 COUNT: NB / (EB) / SB / (WB)	#2 SPEED (mph) NB (EB) / SB (WB)
AUTOS:	108 / 106	35 / 35	/	/
MED. TRUCKS:	0 / 0	↓ / ↓	X	X
HVY TRUCKS:	4 / 4	↓ / ↓	X	X
BUSES:	/	/	/	/
MOTORCYCLES:	/	/	/	/

SPEED ESTIMATED BY: RADAR / (DRIVING) / (OBSERVED)

OTHER NOISE SOURCES: distant AIRCRAFT overhead / RUSTLING LEAVES / distant BARKING DOGS / BIRDS
distant CHILDREN PLAYING / distant TRAFFIC / distant LANDSCAPING / distant TRAINS

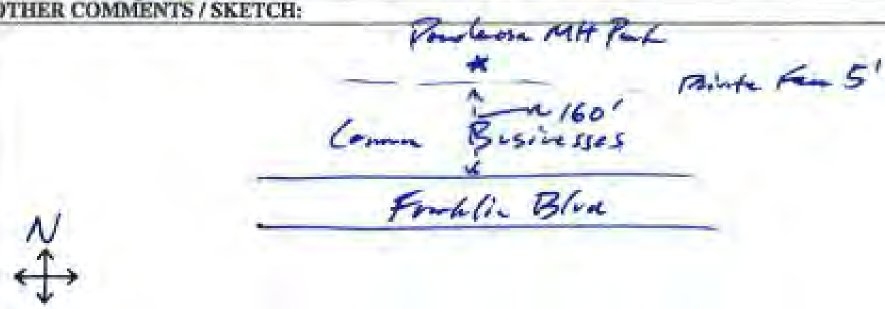
OTHER:

Description / Sketch

TERRAIN: HARD SOFT (MIXED) FLAT OTHER:

PHOTOS: Digital

OTHER COMMENTS / SKETCH:



Measurement Site M3—View to West

Measurement Site M3—View to East

Measurement Sites M4—Field Data Sheet

FIELD MEASUREMENT DATA SHEET

Project Name: Franklin Blvd   Job # B0457E

SITE IDENTIFICATION: M4   OBSERVER(s): Romero
START DATE & TIME: 11/10/14 4:45   END DATE & TIME: 11/10/14 5:10 pm
ADDRESS: 1400 Mississippi Ave.

GPS coordinates:

TEMP: 54 °F HUMIDITY: 60 % R.H. WIND: CALM LIGHT MODERATE VARIABLE
WINDSPEED: 0-2 MPH DIR: N NE E SE S SW W NW STEADY GUSTY ___ MPH
SKY: CLEAR SUNNY DARK PARTLY CLOUDY OVRCST FOG DRIZZLE RAIN Other:

INSTRUMENT: LD 820 SLM / 828, 2560 (Prm mic) TYPE: 1 2   SERIAL #: 1813, 1967, 2979
CALIBRATOR: LD CAL 200   SERIAL #: 2239
CALIBRATION CHECK: PRE-TEST 114.0 dBA SPL POST-TEST 114.0 dBA SPL WINDSCREEN Yes

SETTINGS: A-WEIGHTED SLOW FAST FRONTAL RANDOM ANSI OTHER:

Rec # / Start Time / End Time
M4 / 4:50 / 5:05 : L_{eq} 61.0, L_{max} 71.6, L_{min} 51.4, L_{90} 53.8, L_{50} 60.3, L_{10} 64.0, L(1) 66.7
__ / __ / __ : L_{eq} __, L_{max} __, L_{min} __, L_{90} __, L_{50} __, L_{10} __, __
__ / __ / __ : L_{eq} __, L_{max} __, L_{min} __, L_{90} __, L_{50} __, L_{10} __, __
__ / __ / __ : L_{eq} __, L_{max} __, L_{min} __, L_{90} __, L_{50} __, L_{10} __, __

COMMENTS:

PRIMARY NOISE(S): TRAFFIC AIRCRAFT RAIL INDUSTRIAL AMBIENT OTHER
ROADWAY TYPE: Franklin Blvd

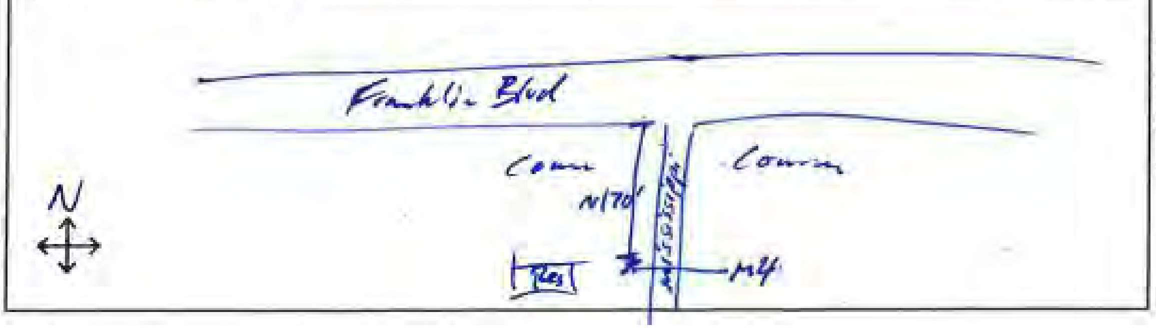
COUNT DURATION: 10 -MINUTE

	NB / EB / SB / WB	SPEED (mph) NB EB / SB WB	#2 COUNT: NB / EB / SB / WB	#2 SPEED (mph) NB EB / SB WB
AUTOS:	78 / 94	35 / 35	/	/
MED. TRUCKS:	2 / 0	↓ / ↓	/	/
HVY TRUCKS:	2 / 4	↓ / ↓	/	/
BUSES:	/	/	/	/
MOTORCYCLES:	/	/	/	/

SPEED ESTIMATED BY: RADAR / DRIVING / OBSERVED

OTHER NOISE SOURCES: distant AIRCRAFT overhead / RUSTLING LEAVES / distant BARKING DOGS / BIRDS
distant CHILDREN PLAYING / distant TRAFFIC / distant LANDSCAPING / distant TRAINS
OTHER:

TERRAIN: HARD SOFT MIXED FLAT OTHER:
PHOTOS: Digital
OTHER COMMENTS / SKETCH:



ID · Weather · Acoustic Measurements · Source Info and Traffic Counts · Description / Sketch

Measurement Site M4—View to North

Measurement Site M4—View to South

Measurement Sites M5—Field Data Sheet

FIELD MEASUREMENT DATA SHEET

PB

Project Name: Franklin Blvd Job # 80457E

SITE IDENTIFICATION: M5 OBSERVER(s): Romero
START DATE & TIME: 11/10/14 1:00pm END DATE & TIME: 11/10/14 1:20pm
ADDRESS: 1450 Brooklyn Ave.

GPS coordinates:

ID

TEMP: 57 °F HUMIDITY: 60 % R.H. WIND: CALM LIGHT MODERATE VARIABLE
WINDSPEED: 0-1 MPH DIR: N NE E SE S SW W NW STEADY GUSTY____MPH
SKY: CLEAR SUNNY DARK PARTLY CLOUDY OVRCST FOG DRIZZLE RAIN Other:

Weather

INSTRUMENT: LD820 SLM, PRM MIC 828, 2560 TYPE: 1 2 SERIAL #: 1313, 1967, 2979
CALIBRATOR: LD CAL 200 SERIAL #: 2239
CALIBRATION CHECK: PRE-TEST 114.0 dBA SPL POST-TEST 114.0 dBA SPL WINDSCREEN Yes

SETTINGS: A-WEIGHTED SLOW FAST FRONTAL RANDOM ANSI OTHER:

Rec # Start Time / End Time
M5, 1:00, 1:15: L_{eq} 61.4, L_{max} 72.5, L_{min} 52.1, L_{90} 54.8, L_{50} 60.2, L_{10} 64.3, L(1) 67.2
___/___/___: L_{eq}___, L_{max}___, L_{min}___, L_{90}___, L_{50}___, L_{10}___, ___
___/___/___: L_{eq}___, L_{max}___, L_{min}___, L_{90}___, L_{50}___, L_{10}___, ___
___/___/___: L_{eq}___, L_{max}___, L_{min}___, L_{90}___, L_{50}___, L_{10}___, ___

COMMENTS:

Acoustic Measurements

PRIMARY NOISE(S): TRAFFIC AIRCRAFT RAIL INDUSTRIAL AMBIENT OTHER
ROADWAY TYPE: Franklin Blvd

COUNT DURATION: 10 -MINUTE SPEED (mph) #2 COUNT: #2 SPEED (mph)

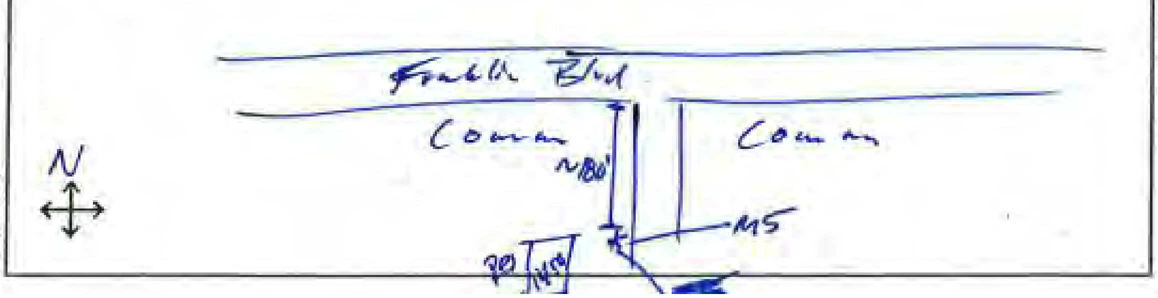
	NB / EB / SB / WB	NB EB / SB WB	NB / EB / SB / WB	NB EB / SB WB
AUTOS:	148 / 117	35 / 35	/	/
MED. TRUCKS:	0 / 0	↓ / ↓	/	/
HVY TRUCKS:	3 / 4	↓ / ↓	/	/
BUSES:	/	/	/	/
MOTORCYCLES:	/	/	/	/

SPEED ESTIMATED BY: RADAR / DRIVING / OBSERVED

OTHER NOISE SOURCES: distant AIRCRAFT overhead / RUSTLING LEAVES / distant BARKING DOGS / BIRDS
distant CHILDREN PLAYING / distant TRAFFIC / distant LANDSCAPING / distant TRAINS
OTHER:

Source Info and Traffic Counts

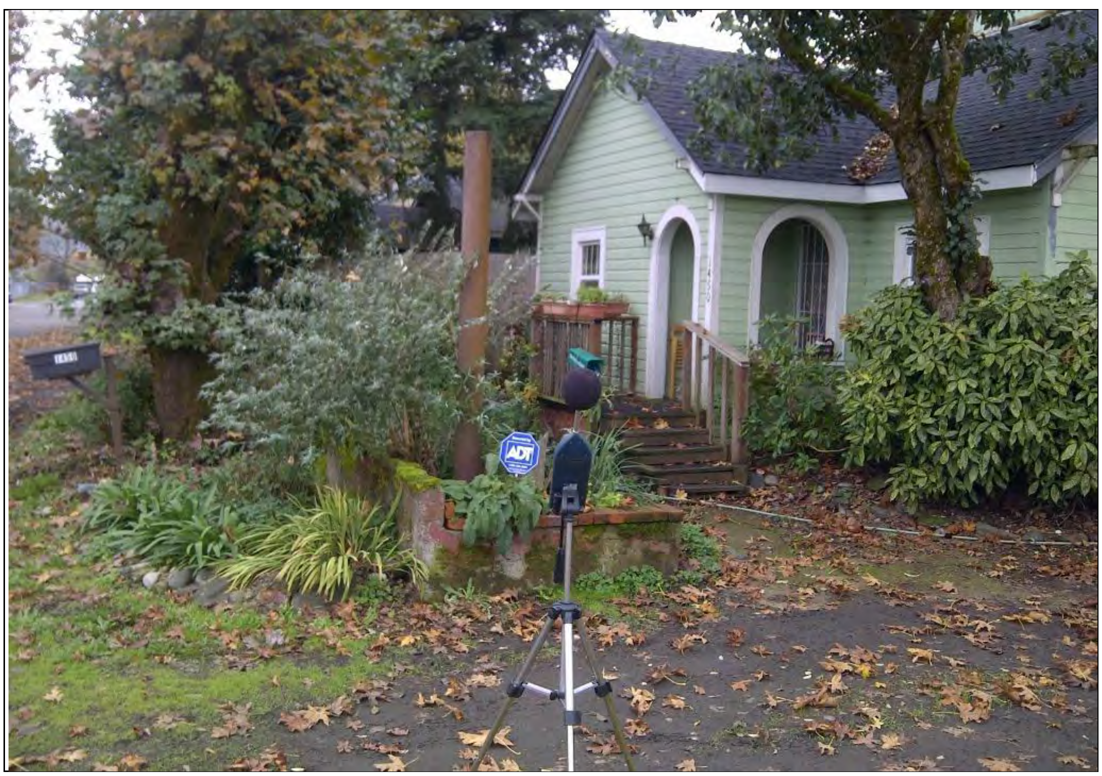
TERRAIN: HARD SOFT MIXED FLAT OTHER:
PHOTOS: Digital
OTHER COMMENTS / SKETCH:



Description / Sketch

Measurement Site M5—View to North

Measurement Site M5—View to South



Measurement Sites M6—Field Data Sheet

FIELD MEASUREMENT DATA SHEET

Project Name: Franklin Blvd   Job # B0457E

ID

SITE IDENTIFICATION: M6   OBSERVER(s): Romero
START DATE & TIME: 11/10/14 11:35am   END DATE & TIME: 11/10/14 11:50am
ADDRESS: 4399 Franklin Blvd
3-unit apt Bldg
GPS coordinates:

Weather

TEMP: 50 °F HUMIDITY: 60 % R.H. WIND: CALM (LIGHT) MODERATE VARIABLE
WINDSPEED: 0-4 MPH DIR: N NE E (SE) S SW W NW STEADY GUSTY ___ MPH
SKY: CLEAR SUNNY DARK PARTLY CLOUDY (OVRCST) FOG DRIZZLE RAIN Other:

Acoustic Measurements

INSTRUMENT: LD820 SLM, 828, 2560 (Prim and ...) TYPE: (1) 2   SERIAL #: 1313, 1967, 2979
CALIBRATOR: LD CAL 200   SERIAL #: 2239
CALIBRATION CHECK: PRE-TEST 114.0 dBA SPL POST-TEST 114.0 dBA SPL WINDSCREEN Yes
SETTINGS: A-WEIGHTED SLOW FAST FRONTAL RANDOM ANSI OTHER:

Rec #	Start Time	End Time	L_{eq}	L_{max}	L_{min}	L_{90}	L_{50}	L_{10}	
M6	11:35	11:50	59.9	69.5	48.6	54.4	59.1	62.6	L(1) 65.4

COMMENTS:

Source Info and Traffic Counts

PRIMARY NOISE(S): (TRAFFIC) AIRCRAFT RAIL INDUSTRIAL AMBIENT OTHER
ROADWAY TYPE: Franklin Blvd
COUNT DURATION: 10 -MINUTE

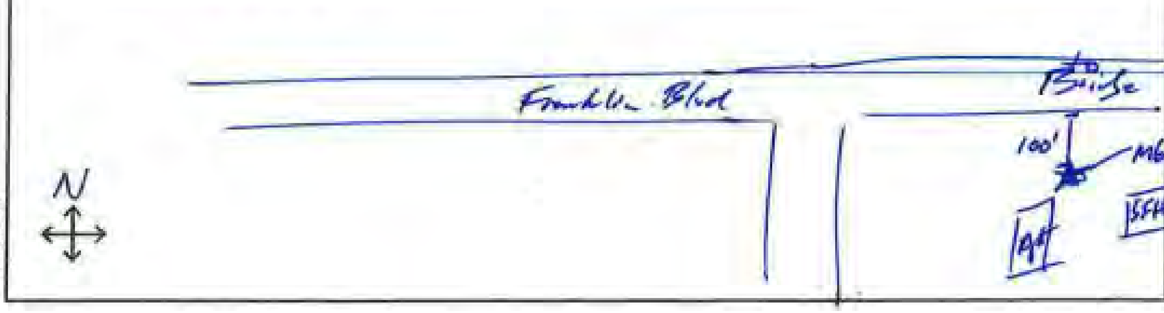
	NB / (EB) / SB / (WB)	SPEED (mph) NB (EB) / SB (WB)	#2 COUNT: NB / (EB) / SB / (WB)	#2 SPEED (mph) NB (EB) / SB (WB)
AUTOS:	91 / 86	40 / 40	/	/
MED. TRUCKS:	0 / 0	↓ / ↓	X / X	X / X
HVY TRUCKS:	2 / 2	↓ / ↓	/	/
BUSES:	/	/	/	/
MOTORCYCLES:	/	/	/	/

SPEED ESTIMATED BY: RADAR / (DRIVING) / (OBSERVED)

OTHER NOISE SOURCES: distant AIRCRAFT overhead / RUSTLING LEAVES / distant BARKING DOGS / BIRDS
distant CHILDREN PLAYING / distant TRAFFIC / distant LANDSCAPING / distant TRAINS
OTHER:

Description / Sketch

TERRAIN: HARD SOFT (MIXED) FLAT OTHER:
PHOTOS: Digital
OTHER COMMENTS / SKETCH:



Measurement Site M6—View to North

Measurement Site M6—View to South

Appendix E—TNM® 2.5 Output Files

TNM® models included electronically. Modeling files developed for this report are as follows:

Model Name	**Description**
MODEL VALIDATION RUNS	
Franklin_Val1	Validation model for measurement 1
Franklin_Val2	Validation model for measurement 2
Franklin_Val3	Validation model for measurement 3
Franklin_Val4	Validation model for measurement 4
Franklin_Val5	Validation model for measurement 5
Franklin_Val6	Validation model for measurement 6
EXISTING CONDITIONS MODEL RUN	
Franklin_Existing	Existing (2013) noise levels calculated for the draft report.
NO BUILD CONDITIONS MODEL RUNS	
Franklin_NoBld	No Build Alternative (2035) noise levels calculated for draft report.
Franklin_PeakTruckNoBld	Peak Truck Hour Levels (2035) at 6 modeled sites to compare with Peak Hour Levels from representative traffic conditions.
BUILD CONDITIONS MODEL RUN	
Franklin_Build	Build (2035) noise levels calculated for the draft report.
BUILD FUTURE IMPACT DISTANCE MODEL RUN	
Franklin_Build_FutureImpactDist	Build (2035) noise levels calculated for future development consideration.

Appendix F—Instrument Calibration Forms

Annual manufacturer calibration forms are provided in Appendix F for all instrumentation used during field monitoring. Note that the following forms were the current validation records at the time of field monitoring in November of 2014.

PCB PIEZOTRONICS
A PCB GROUP COMPANY

COPY

Certificate of Calibration and Conformance

Certificate Number 2014-195174

Instrument Model 820, Serial Number 1313, was calibrated on 23 Sep 2014. The instrument meets factory specifications per Procedure D0001.8160, ANSI S1.4 1983, IEC 651-Type 1 1979, and IEC 804-Type 1 1985.

Instrument found to be in calibration as received: YES
Date Calibrated: 23 Sep 2014
Calibration due: 23 Sep 2015

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO.
Larson Davis	LDSigGn/2239	0653 / 0101	12 Months	14 Apr 2015	2014-189483

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 24 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

"AS RECEIVED" data same as shipped data.
Tested with PRM828-1967

Signed: [signature]
Technician: Eric Olson

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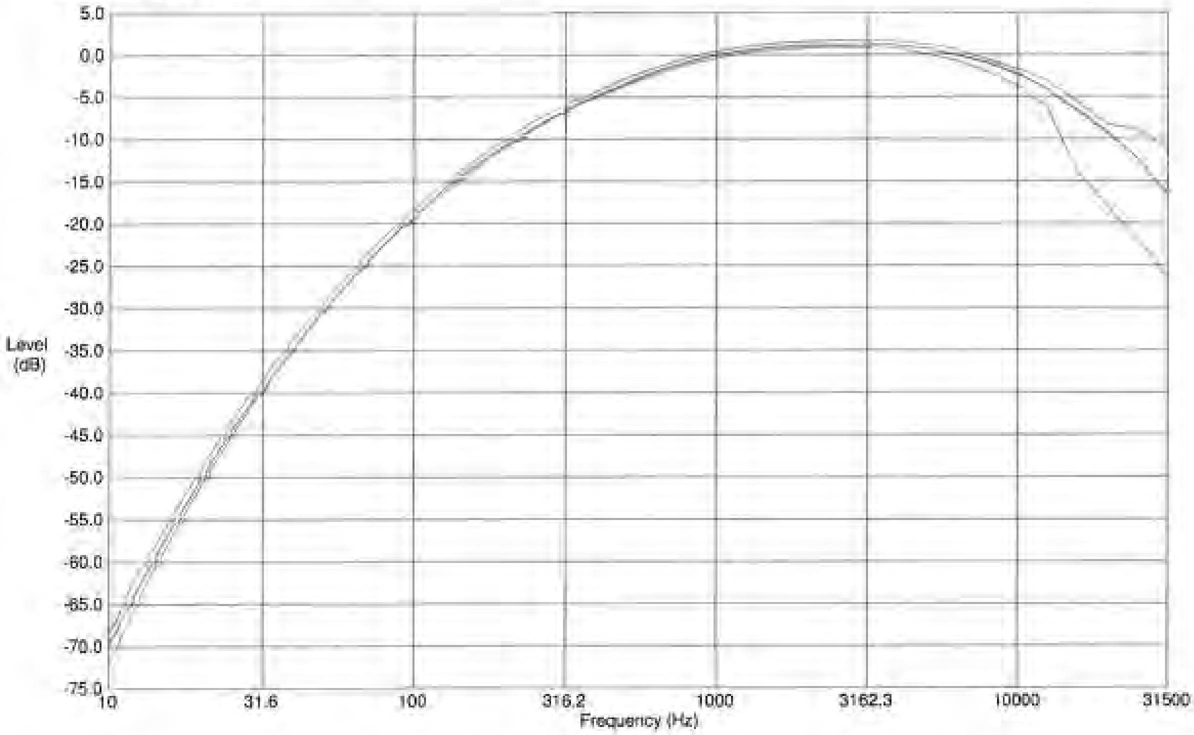
Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Sound Level Meter Model: 820A Serial Number: A1313
Certificate of A-Weight Electrical Conformance

This Type 1 Sound Level Meter (including attached PRM828 preamplifier and ADP005 18 pF input adapter) was calibrated with a reference 1kHz sine wave at a level of 114.0 dBSPL. The instrument's A-weighted response was then electrically tested using a 2.1 Vrms sinewave at exact frequencies as specified in IEC 60651 (2001-10) and ANSI S1.4-1983.



Freq (Hz)	Theor	Measured	Error	Tolerance
10.00	-70.4	-69.80	0.60	+1.8, -1.8
12.59	-63.4	-63.50	-0.10	+1.5, -1.5
15.85	-56.7	-56.80	-0.10	+1.2, -1.2
19.95	-50.5	-50.80	-0.30	+1.0, -1.0
25.12	-44.7	-44.90	-0.20	+0.9, -0.9
31.62	-39.4	-39.80	-0.40	+0.7, -0.7
39.81	-34.6	-35.00	-0.40	+0.7, -0.7
50.12	-30.2	-30.40	-0.20	+0.5, -0.5
63.10	-26.2	-26.50	-0.30	+0.5, -0.5
79.43	-22.5	-22.90	-0.40	+0.5, -0.5
100.00	-19.1	-19.40	-0.30	+0.5, -0.5
125.89	-16.1	-16.20	-0.10	+0.5, -0.5
158.49	-13.4	-13.50	-0.10	+0.5, -0.5
199.53	-10.9	-11.10	-0.20	+0.5, -0.5
251.19	-8.6	-8.90	-0.30	+0.5, -0.5
316.23	-6.6	-6.90	-0.30	+0.4, -0.4
398.11	-4.8	-5.00	-0.20	+0.4, -0.4
501.19	-3.2	-3.40	-0.20	+0.4, -0.4

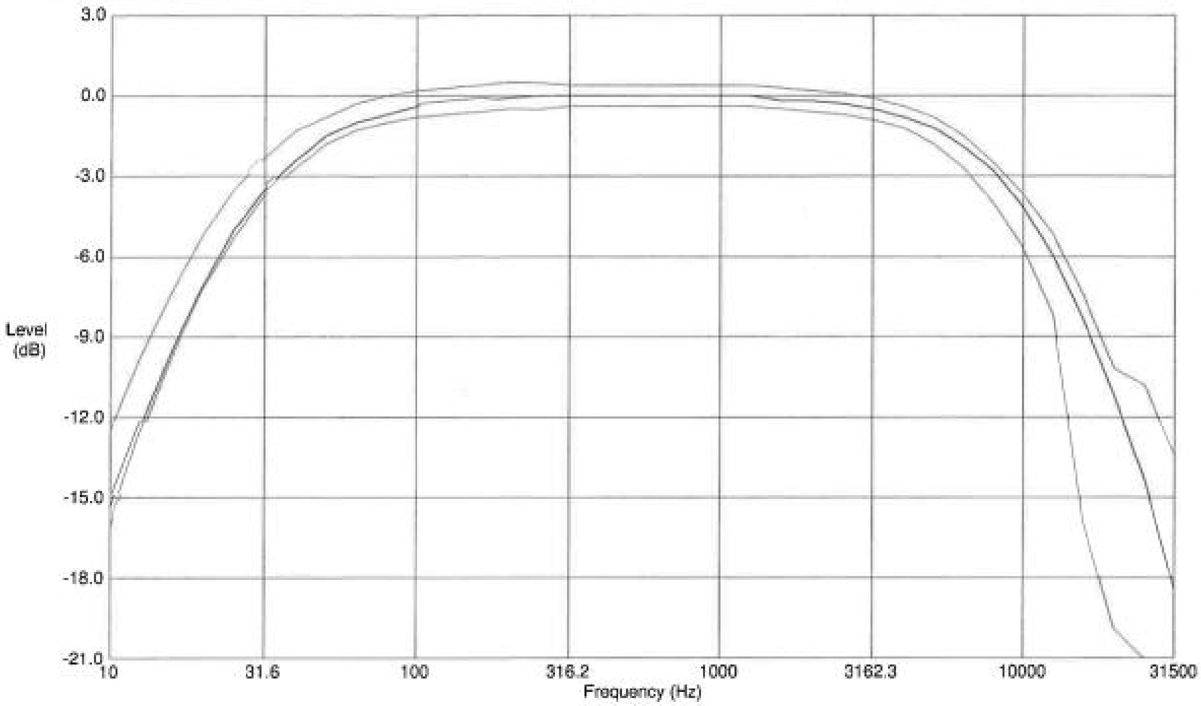
Freq (Hz)	Theor	Measured	Error	Tolerance
630.96	-1.9	-2.00	-0.10	+0.4, -0.4
794.33	-0.8	-0.90	-0.10	+0.4, -0.4
1000.00	0.0	0.00	0.00	+0.4, -0.4
1258.90	0.6	0.50	-0.10	+0.4, -0.4
1584.90	1.0	0.90	-0.10	+0.4, -0.4
1995.30	1.2	1.10	-0.10	+0.4, -0.4
2511.90	1.3	1.10	-0.20	+0.4, -0.4
3162.30	1.2	1.10	-0.10	+0.4, -0.4
3981.10	1.0	0.90	-0.10	+0.4, -0.4
5011.90	0.5	0.50	0.00	+0.5, -0.5
6309.60	-0.1	-0.10	0.00	+0.5, -0.7
7943.30	-1.1	-1.00	0.10	+0.5, -1.0
10000.00	-2.5	-2.40	0.10	+0.7, -1.3
12589.00	-4.3	-4.30	0.00	+1.0, -2.0
15849.00	-6.6	-6.60	0.00	+1.0, -7.4
19953.00	-9.3	-9.30	0.00	+1.0, -8.7
25119.00	-12.4	-12.50	-0.10	+3.5, -9.6
31623.00	-15.8	-16.60	-0.80	+4.3, -10.7

This instrument is in compliance with IEC 60651 (2001-10) 6.1 and 9.2.2, ANSI S1.4-1983 5.1 and 8.2.1, and IEC 60804 (2001-10) 5.1 for Type 1 sound level meters when used with a Larson Davis Type 1 microphone.

Technician: Eric Olson   Test Date: 23SEP2014

Sound Level Meter Model: 820A Serial Number: A1313
Certificate of C-Weight Electrical Conformance

This Type 1 Sound Level Meter (including attached PRM828 preamplifier and ADP005 18 pF input adapter) was calibrated with a reference 1kHz sine wave at a level of 114.0 dBSPL. The instrument's C-weighted response was then electrically tested using a 2.1 Vrms sinewave at exact frequencies as specified in IEC 60651 (2001-10) and ANSI S1.4-1983.



Freq (Hz)	Theor	Measured	Error	Tolerance
10.00	-14.3	-15.30	-1.00	+1.8, -1.8
12.59	-11.2	-12.30	-1.10	+1.5, -1.5
15.85	-8.5	-9.50	-1.00	+1.2, -1.2
19.95	-6.2	-7.10	-0.90	+1.0, -1.0
25.12	-4.4	-5.00	-0.60	+0.9, -0.9
31.62	-3.0	-3.50	-0.50	+0.7, -0.7
39.81	-2.0	-2.40	-0.40	+0.7, -0.7
50.12	-1.3	-1.50	-0.20	+0.5, -0.5
63.10	-0.8	-1.00	-0.20	+0.5, -0.5
79.43	-0.5	-0.70	-0.20	+0.5, -0.5
100.00	-0.3	-0.40	-0.10	+0.5, -0.5
125.89	-0.2	-0.30	-0.10	+0.5, -0.5
158.49	-0.1	-0.20	-0.10	+0.5, -0.5
199.53	0.0	-0.10	-0.10	+0.5, -0.5
251.19	0.0	0.00	0.00	+0.5, -0.5
316.23	0.0	0.00	0.00	+0.4, -0.4
398.11	0.0	0.00	0.00	+0.4, -0.4
501.19	0.0	0.00	0.00	+0.4, -0.4

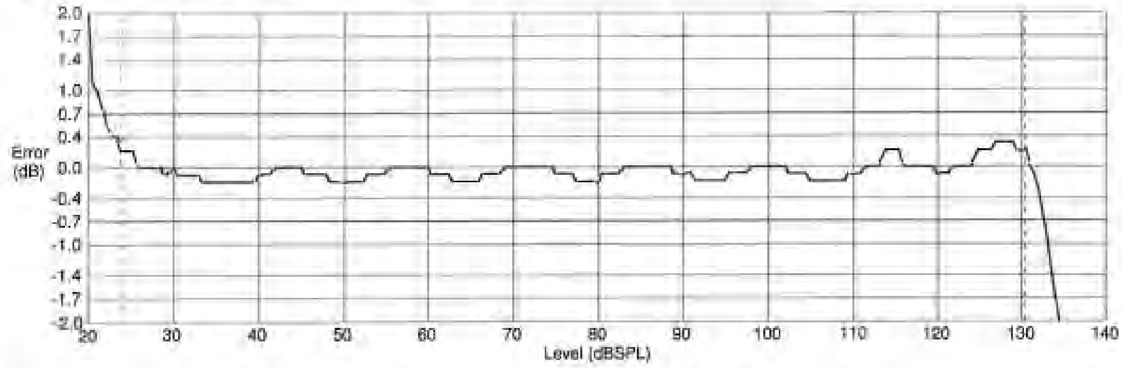
Freq (Hz)	Theor	Measured	Error	Tolerance
630.96	0.0	0.00	0.00	+0.4, -0.4
794.33	0.0	0.00	0.00	+0.4, -0.4
1000.00	0.0	0.00	0.00	+0.4, -0.4
1258.90	0.0	0.00	0.00	+0.4, -0.4
1584.90	-0.1	-0.20	-0.10	+0.4, -0.4
1995.30	-0.2	-0.20	0.00	+0.4, -0.4
2511.90	-0.3	-0.30	0.00	+0.4, -0.4
3162.30	-0.5	-0.50	0.00	+0.4, -0.4
3981.10	-0.8	-0.80	0.00	+0.4, -0.4
5011.90	-1.3	-1.20	0.10	+0.5, -0.5
6309.60	-2.0	-1.90	0.10	+0.5, -0.7
7943.30	-3.0	-2.80	0.20	+0.5, -1.0
10000.00	-4.4	-4.20	0.20	+0.7, -1.3
12589.00	-6.2	-6.00	0.20	+1.0, -2.0
15849.00	-8.5	-8.40	0.10	+1.0, -7.4
19953.00	-11.2	-11.20	0.00	+1.0, -8.7
25119.00	-14.3	-14.30	0.00	+3.5, -9.6
31623.00	-17.7	-18.40	-0.70	+4.3, -10.7

This instrument is in compliance with IEC 60651 (2001-10) 6.1 and 9.2.2, ANSI S1.4-1983 5.1 and 8.2.1, and IEC 60804 (2001-10) 5.1 for Type 1 sound level meters when used with a Larson Davis Type 1 microphone.

Technician: Eric Olson Test Date: 23SEP2014

Sound Level Meter Model: 820A Serial Number: A1313
Log Linearity, Differential Linearity and Range Data

This Type 1 Sound Level Meter (including attached PRM828 preamplifier and ADP005 18 pF input adapter) was calibrated with a reference 1kHz sine wave at a level of 114.0 dBSPL. The instrument's Log Linearity A-weighted slow response was then electrically tested using a 1kHz sine wave from 18.0 dBSPL to 138.0 dBSPL in 0.5 dB increments.



Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB	Levl dBSPL	Meas dBSPL	Err dB
18.0	20.3	2.3	38.5	38.3	-0.2	59.0	59.0	0.0	79.5	79.3	-0.2	100.0	100.0	0.0	120.5	120.4	-0.1
18.5	20.5	2.0	39.0	38.8	-0.2	59.5	59.5	0.0	80.0	79.8	-0.2	100.5	100.5	0.0	121.0	120.9	-0.1
19.0	20.9	1.9	39.5	39.3	-0.2	60.0	60.0	0.0	80.5	80.4	-0.1	101.0	101.0	0.0	121.5	121.4	-0.1
19.5	21.1	1.6	40.0	39.9	-0.1	60.5	60.4	-0.1	81.0	80.9	-0.1	101.5	101.5	0.0	122.0	122.0	0.0
20.0	21.3	1.3	40.5	40.4	-0.1	61.0	60.9	-0.1	81.5	81.4	-0.1	102.0	102.0	0.0	122.5	122.5	0.0
20.5	21.6	1.1	41.0	40.9	-0.1	61.5	61.4	-0.1	82.0	81.9	-0.1	102.5	102.4	-0.1	123.0	123.0	0.0
21.0	22.0	1.0	41.5	41.4	-0.1	62.0	61.9	-0.1	82.5	82.4	-0.1	103.0	102.9	-0.1	123.5	123.5	0.0
21.5	22.4	0.9	42.0	42.0	0.0	62.5	62.4	-0.1	83.0	83.0	0.0	103.5	103.4	-0.1	124.0	124.0	0.0
22.0	22.7	0.7	42.5	42.5	0.0	63.0	62.8	-0.2	83.5	83.5	0.0	104.0	103.9	-0.1	124.5	124.6	0.1
22.5	23.0	0.5	43.0	43.0	0.0	63.5	63.3	-0.2	84.0	84.0	0.0	104.5	104.4	-0.1	125.0	125.2	0.2
23.0	23.4	0.4	43.5	43.5	0.0	64.0	63.8	-0.2	84.5	84.5	0.0	105.0	104.8	-0.2	125.5	125.7	0.2
23.5	23.9	0.4	44.0	44.0	0.0	64.5	64.3	-0.2	85.0	85.0	0.0	105.5	105.3	-0.2	126.0	126.2	0.2
24.0	24.2	0.2	44.5	44.5	0.0	65.0	64.8	-0.2	85.5	85.5	0.0	106.0	105.8	-0.2	126.5	126.7	0.2
24.5	24.7	0.2	45.0	45.0	0.0	65.5	65.3	-0.2	86.0	86.0	0.0	106.5	106.3	-0.2	127.0	127.3	0.3
25.0	25.2	0.2	45.5	45.4	-0.1	66.0	65.8	-0.2	86.5	86.5	0.0	107.0	106.8	-0.2	127.5	127.8	0.3
25.5	25.7	0.2	46.0	45.9	-0.1	66.5	66.4	-0.1	87.0	87.0	0.0	107.5	107.3	-0.2	128.0	128.3	0.3
26.0	26.0	0.0	46.5	46.4	-0.1	67.0	66.9	-0.1	87.5	87.5	0.0	108.0	107.8	-0.2	128.5	128.8	0.3
26.5	26.5	0.0	47.0	46.9	-0.1	67.5	67.4	-0.1	88.0	88.0	0.0	108.5	108.3	-0.2	129.0	129.3	0.3
27.0	27.0	0.0	47.5	47.4	-0.1	68.0	67.9	-0.1	88.5	88.5	0.0	109.0	108.8	-0.2	129.5	129.7	0.2
27.5	27.5	0.0	48.0	47.9	-0.1	68.5	68.4	-0.1	89.0	88.9	-0.1	109.5	109.4	-0.1	130.0	130.2	0.2
28.0	28.0	0.0	48.5	48.3	-0.2	69.0	69.0	0.0	89.5	89.4	-0.1	110.0	109.9	-0.1	130.5	130.7	0.2
28.5	28.5	0.0	49.0	48.8	-0.2	69.5	69.5	0.0	90.0	89.9	-0.1	110.5	110.4	-0.1	131.0	131.0	0.0
29.0	28.9	-0.1	49.5	49.3	-0.2	70.0	70.0	0.0	90.5	90.4	-0.1	111.0	110.9	-0.1	131.5	131.4	-0.1
29.5	29.4	-0.1	50.0	49.8	-0.2	70.5	70.5	0.0	91.0	90.9	-0.1	111.5	111.5	0.0	132.0	131.7	-0.3
30.0	30.0	0.0	50.5	50.3	-0.2	71.0	71.0	0.0	91.5	91.3	-0.2	112.0	112.0	0.0	132.5	131.9	-0.6
30.5	30.4	-0.1	51.0	50.8	-0.2	71.5	71.5	0.0	92.0	91.8	-0.2	112.5	112.5	0.0	133.0	132.1	-0.9
31.0	30.9	-0.1	51.5	51.3	-0.2	72.0	72.0	0.0	92.5	92.3	-0.2	113.0	113.0	0.0	133.5	132.2	-1.3
31.5	31.4	-0.1	52.0	51.8	-0.2	72.5	72.5	0.0	93.0	92.8	-0.2	113.5	113.6	0.1	134.0	132.3	-1.7
32.0	31.9	-0.1	52.5	52.3	-0.2	73.0	73.0	0.0	93.5	93.3	-0.2	114.0	114.2	0.2	134.5	132.3	-2.2
32.5	32.4	-0.1	53.0	52.9	-0.1	73.5	73.5	0.0	94.0	93.8	-0.2	114.5	114.7	0.2	135.0	132.2	-2.8
33.0	32.9	-0.1	53.5	53.4	-0.1	74.0	74.0	0.0	94.5	94.3	-0.2	115.0	115.2	0.2	135.5	132.2	-3.3
33.5	33.3	-0.2	54.0	53.9	-0.1	74.5	74.5	0.0	95.0	94.8	-0.2	115.5	115.7	0.2	136.0	132.0	-4.0
34.0	33.8	-0.2	54.5	54.4	-0.1	75.0	74.9	-0.1	95.5	95.4	-0.1	116.0	116.0	0.0	136.5	132.0	-4.5
34.5	34.3	-0.2	55.0	54.9	-0.1	75.5	75.4	-0.1	96.0	95.9	-0.1	116.5	116.5	0.0	137.0	132.1	-4.9
35.0	34.8	-0.2	55.5	55.5	0.0	76.0	75.9	-0.1	96.5	96.4	-0.1	117.0	117.0	0.0	137.5	132.2	-5.3
35.5	35.3	-0.2	56.0	56.0	0.0	76.5	76.4	-0.1	97.0	96.9	-0.1	117.5	117.5	0.0	138.0	132.2	-5.8
36.0	35.8	-0.2	56.5	56.5	0.0	77.0	76.9	-0.1	97.5	97.4	-0.1	118.0	118.0	0.0			
36.5	36.3	-0.2	57.0	57.0	0.0	77.5	77.3	-0.2	98.0	98.0	0.0	118.5	118.5	0.0			
37.0	36.8	-0.2	57.5	57.5	0.0	78.0	77.8	-0.2	98.5	98.5	0.0	119.0	119.0	0.0			
37.5	37.3	-0.2	58.0	58.0	0.0	78.5	78.3	-0.2	99.0	99.0	0.0	119.5	119.5	0.0			
38.0	37.8	-0.2	58.5	58.5	0.0	79.0	78.8	-0.2	99.5	99.5	0.0	120.0	119.9	-0.1			

Plotted per typical sensitivity of a 2541 microphone; 44.5 mV/Pa & 17.1 pF.

Overload occurs at 130.5 dBSPL.
Primary indicator range: 106.4 dB (lower limit: 24.0 dBSPL to upper limit: 130.4 dBSPL).
Dynamic range: 112.8 dB (noise floor: 17.6 dBSPL to upper limit: 130.4 dBSPL).

This instrument is in compliance with IEC 60651 (2001-10) 7.9 and 7.10, ANSI S1.4-1983 3.2 and IEC 60804 (2001-10) 9.2.1 for Type 1 sound level meters when used with a Larson Davis Type 1 microphone.

Technician: Eric Olson Test Date: 23SEP2014

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Certificate of Calibration and Conformance

Certificate Number 2014-195172

Instrument Model PRM828, Serial Number 1967, was calibrated on 23 Sep 2014. The instrument meets factory specifications per Procedure D0001.8135.

Instrument found to be in calibration as received: YES
Date Calibrated: 23 Sep 2014
Calibration due: 23 Sep 2015

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL DUE	TRACEABILITY NO
Larson Davis	2900 / 2239	0608 / 0110	12 Months	20 Dec 2014	2013-184004
Hewlett Packard	34401A	US36023299	12 Months	7 May 2015	6515697

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Temperature: 24 ° Centigrade

Relative Humidity: 24 %

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

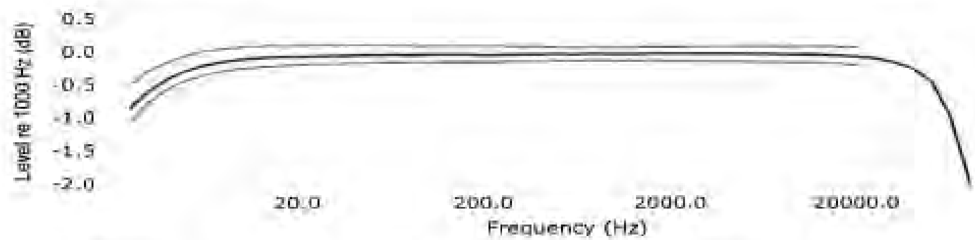
"AS RECEIVED" data same as shipped data.

Signed: [signature]
Technician: Eric Olson

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

Preamplifier Model: PRM828 Serial Number: 1967
Frequency Response Test Report

Frequency response electrically tested at 120.0 dBμV using a 18 pF capacitor to simulate microphone capacitance.



Frequency (Hz)	Relative Level (dB)	Uncertainty (dB)	Limits (dB)	Frequency (Hz)	Relative Level (dB)	Uncertainty (dB)	Limits (dB)
2.5	-0.81	0.08	-0.46,-1.02	631.0	-0.00	0.02	0.10,-0.10
3.2	-0.55	0.06	-0.25,-0.73	794.3	-0.00	0.02	0.10,-0.10
4.0	-0.37	0.06	-0.12,-0.52	1000.0	0.00	0.02	0.10,-0.10
5.0	-0.25	0.04	-0.02,-0.40	1258.9	0.00	0.02	0.10,-0.10
6.3	-0.17	0.04	0.05,-0.31	1584.9	0.00	0.02	0.11,-0.11
7.9	-0.11	0.04	0.08,-0.26	1995.3	0.00	0.02	0.11,-0.11
10.0	-0.08	0.02	0.11,-0.22	2511.9	0.00	0.02	0.11,-0.11
12.6	-0.05	0.02	0.13,-0.20	3162.3	0.00	0.02	0.11,-0.11
15.8	-0.04	0.02	0.13,-0.18	3981.1	0.00	0.02	0.11,-0.11
20.0	-0.04	0.02	0.13,-0.16	5011.9	0.00	0.02	0.12,-0.12
25.1	-0.03	0.02	0.13,-0.15	6309.6	-0.00	0.02	0.12,-0.12
31.6	-0.03	0.02	0.14,-0.14	7943.3	-0.01	0.02	0.12,-0.13
39.8	-0.02	0.02	0.14,-0.14	10000.0	-0.01	0.02	0.12,-0.13
50.1	-0.02	0.02	0.13,-0.14	12589.3	-0.01	0.02	0.12,-0.14
63.1	-0.01	0.02	0.13,-0.13	15848.9	-0.03	0.02	0.11,-0.15
79.4	-0.01	0.02	0.13,-0.13	19952.6	-0.05	0.02	0.09,-0.17
100.0	-0.01	0.02	0.12,-0.12	25118.9	-0.08	0.02	inf,-inf
125.9	-0.01	0.02	0.12,-0.12	31622.8	-0.13	0.02	inf,-inf
158.5	-0.01	0.02	0.12,-0.12	39810.7	-0.23	0.02	inf,-inf
199.5	-0.02	0.02	0.12,-0.12	50118.7	-0.43	0.02	inf,-inf
251.2	-0.01	0.02	0.12,-0.12	63095.7	-0.92	0.05	inf,-inf
316.2	-0.01	0.02	0.11,-0.11	79432.8	-1.83	0.05	inf,-inf
398.1	-0.01	0.02	0.11,-0.11	100000.0	-3.05	0.05	inf,-inf
501.2	-0.00	0.02	0.10,-0.10	125892.5	-4.51	0.06	inf,-inf

1000 Hz measured level: 119.030 dBμV, -0.970 dB re input (0.033 dB uncertainty; -1.533 dB to -0.567 dB limit)
1 kHz (1/3 Octave) Noise Floor : 0.33 μV, -9.50 dBμV (0.47 dB uncertainty; -3.00 dB limit)
Flat (20 Hz - 20 kHz) Noise Floor : 3.50 μV, 10.89 dBμV (0.47 dB uncertainty; 17.00 dB limit)
A-weight Noise Floor : 1.92 μV, 5.65 dBμV (0.46 dB uncertainty; 13.00 dB limit)
Environmental conditions: 23.7 °C, 41.4 %RH (0.3 °C, 3 %RH uncertainty)
Uncertainties are given as expanded uncertainty at ~95 percent confidence level (k = 2).
Test Procedure: D0001.8135 with PRM828 (SMD)
This frequency response is in compliance with manufacturers specification for the item tested.
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Technician: Eric Olson Test Date: 23 Sep 2014 09:03:58

Test Location: Larson Davis, a division of PCB Piezotronics, Inc.
1681 West 820 North, Provo, Utah 84601
Tel: 716 684-0001 www.LarsonDavis.com

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Calibration Certificate

Certificate Number 2014002873

Customer:
Parsons Brinkerhoff
Suite3200
999 Third Avenue
Seattle, WA 98104, United States

Model Number	2560	***Procedure Name***	Microphone		
Serial Number	2979	***Technician***	Abraham Ortega		
Test Results	**Pass**	***Calibration Date***	22 Sep 2014		
Initial Condition	AS RECEIVED same as shipped	***Calibration Due***	22 Sep 2015		
		Temperature	25.1	°C	± 0.01 °C
Description	1/2 inch Microphone - RI - 200V	***Humidity***	42.9	%RH	± 0.5 %RH
		Static Pressure	101.45	kPa	± 0.03 kPa

Evaluation Method Tested electrically using an electrostatic actuator.

Compliance Standards Compliant to Manufacturer Specifications.

Larson Davis, a division of PCB Piezotronics, Inc. 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.

The quality system is registered to ISO 9001:2008.

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 will 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

Description	Cal Date	Cal Due	Cal Standard
Sound Level Meter / Real Time Analyzer	07/21/2014	07/21/2015	001230
Microphone Calibration System	09/03/2014	09/03/2015	001233
1/2" Preamplifier	12/11/2013	12/11/2014	001274
Agilent 34401A DMM	12/04/2013	12/04/2014	001329
Larson Davis CAL250 Acoustic Calibrator	01/03/2014	01/03/2015	003030
1/2" Preamplifier	12/11/2013	12/11/2014	006506
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/11/2014	09/11/2015	006507
1/2 inch Microphone - RI - 200V	01/31/2014	01/31/2015	006510
1/2 inch Microphone - RI - 200V	08/12/2014	08/12/2015	006519
Larson Davis 1/2" Preamplifier 7-pin LEMO	09/11/2014	09/11/2015	006530
Larson Davis 1/2" Preamplifier 7-pin LEMO	08/14/2014	08/14/2015	006531

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Sensitivity

Measurement	Test Result [mV/Pa]	Lower limit [mV/Pa]	Upper limit [mV/Pa]	Expanded Uncertainty [mV/Pa]	Result
Open Circuit Sensitivity	45.64	-500.00	500.00	0.96	Pass

-- End of measurement results--

Capacitance

Measurement	Test Result [pF]
Capacitance	22.00

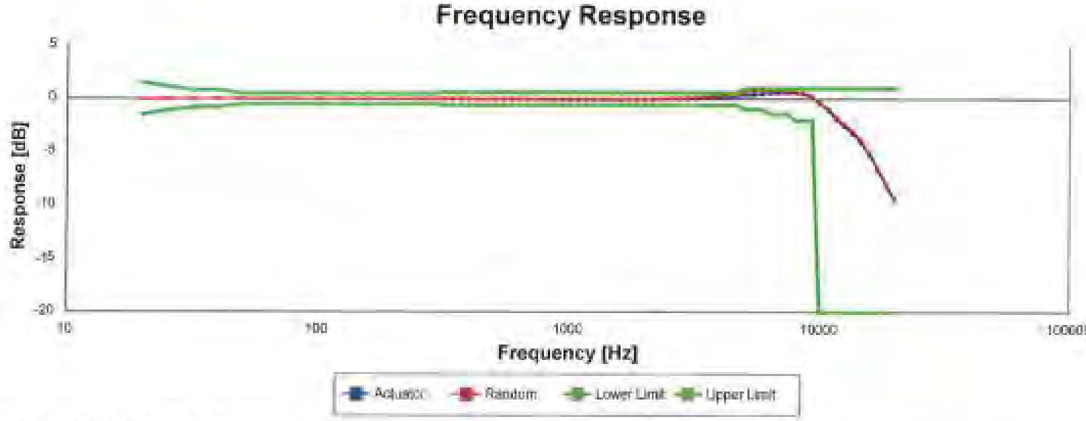
-- End of measurement results--

Lower Limiting Frequency

Measurement	Test Result [Hz]	Lower limit [Hz]	Upper limit [Hz]	Result
-3 dB Frequency	0.06	-500.00	500.00	Pass

-- End of measurement results--

Frequency Response



Data is normalized for 0 dB @ 251.19 Hz.

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
19.95	-0.02	-0.02	-1.50	1.50	Pass
25.12	0.00	0.00	-1.10	1.10	Pass
31.62	0.02	0.02	-0.80	0.80	Pass
39.81	0.02	0.02	-0.80	0.80	Pass
50.12	0.03	0.03	-0.50	0.50	Pass
63.10	0.03	0.03	-0.50	0.50	Pass
79.43	0.02	0.02	-0.50	0.50	Pass
100.00	0.02	0.02	-0.50	0.50	Pass
125.89	0.01	0.01	-0.50	0.50	Pass
158.49	0.01	0.01	-0.50	0.50	Pass
199.53	0.01	0.01	-0.50	0.50	Pass

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Certificate Number 2014002873

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
251.19	0.00	0.00	-0.50	0.50	Pass
271.23	0.00	0.00	-0.50	0.50	Pass
292.86	0.00	0.00	-0.50	0.50	Pass
316.23	-0.01	-0.01	-0.60	0.60	Pass
341.45	-0.01	-0.01	-0.60	0.60	Pass
368.69	-0.01	-0.01	-0.60	0.60	Pass
398.11	-0.01	-0.01	-0.60	0.60	Pass
429.87	-0.02	-0.02	-0.60	0.60	Pass
464.16	-0.02	-0.02	-0.60	0.60	Pass
501.19	-0.02	-0.02	-0.60	0.60	Pass
541.17	-0.03	-0.03	-0.60	0.60	Pass
584.34	-0.03	-0.03	-0.60	0.60	Pass
630.96	-0.03	-0.03	-0.60	0.60	Pass
681.29	-0.04	-0.03	-0.60	0.60	Pass
735.64	-0.04	-0.03	-0.60	0.60	Pass
794.33	-0.04	-0.03	-0.60	0.60	Pass
857.70	-0.05	-0.04	-0.60	0.60	Pass
926.12	-0.05	-0.04	-0.60	0.60	Pass
1,000.00	-0.05	-0.04	-0.60	0.60	Pass
1,079.78	-0.05	-0.04	-0.60	0.60	Pass
1,165.91	-0.05	-0.04	-0.60	0.60	Pass
1,258.93	-0.05	-0.04	-0.60	0.60	Pass
1,359.36	-0.05	-0.04	-0.60	0.60	Pass
1,467.80	-0.05	-0.04	-0.60	0.60	Pass
1,584.89	-0.05	-0.04	-0.60	0.60	Pass
1,711.33	-0.04	-0.03	-0.60	0.60	Pass
1,847.85	-0.03	-0.02	-0.60	0.60	Pass
1,995.26	-0.03	-0.02	-0.60	0.60	Pass
2,154.43	-0.02	0.00	-0.60	0.60	Pass
2,326.31	0.01	0.03	-0.60	0.60	Pass
2,511.89	0.02	0.05	-0.60	0.60	Pass
2,712.27	0.04	0.08	-0.60	0.60	Pass
2,928.64	0.06	0.12	-0.60	0.60	Pass
3,162.28	0.09	0.17	-0.60	0.60	Pass
3,414.55	0.13	0.24	-0.60	0.60	Pass
3,686.95	0.16	0.29	-0.60	0.60	Pass
3,981.07	0.20	0.36	-0.60	0.60	Pass
4,298.66	0.25	0.45	-0.60	0.60	Pass
4,641.59	0.30	0.56	-0.60	0.60	Pass
5,011.87	0.36	0.66	-1.00	1.00	Pass
5,411.70	0.42	0.74	-1.00	1.00	Pass
5,843.41	0.49	0.79	-1.00	1.00	Pass
6,309.57	0.56	0.81	-1.40	1.00	Pass
6,812.92	0.59	0.79	-1.40	1.00	Pass
7,356.42	0.63	0.78	-1.40	1.00	Pass
7,943.28	0.59	0.69	-2.00	1.00	Pass
8,576.96	0.49	0.57	-2.00	1.00	Pass
9,261.19	0.21	0.27	-2.00	1.00	Pass
10,000.00	-0.38	-0.30		1.00	Pass
10,797.75	-1.03	-0.93		1.00	Pass
11,659.14	-1.87	-1.72		1.00	Pass
12,589.25	-2.60	-2.38		1.00	Pass
13,593.56	-3.27	-3.00		1.00	Pass

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Certificate Number 2014002873

Frequency [Hz]	Actuator [dB]	Random [dB]	Lower limit [dB]	Upper limit [dB]	Result
14,677.99	-4.12	-3.90		1.00	Pass
15,848.93	-5.20	-5.04		1.00	Pass
17,113.28	-6.64	-6.54		1.00	Pass
18,478.50	-8.03	-7.91		1.00	Pass
19,952.62	-9.42	-9.34		1.00	Pass

-- End of measurement results--

Signatory: *Abraham Ortega*

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PCB PIEZOTRONICS
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Certificate of Calibration and Conformance

Certificate Number 2014-189780

Instrument Model CAL200, Serial Number 2239, was calibrated on 18 Apr 2014. The instrument meets factory specifications per Procedure D0001.8190, IEC 60942:2003.

Instrument found to be in calibration as received: YES
Date Calibrated: 18 Apr 2014
Calibration due: 18 Apr 2015

Calibration Standards Used

MANUFACTURER	MODEL	SERIAL NUMBER	INTERVAL	CAL. DUE	TRACEABILITY NO
Larson Davis	2559	2506	12 Months	13 Jun 2014	29027
Larson Davis	MTS1000/2201	0111	12 Months	22 Aug 2014	SM082213
Larson Davis	PRM902	0480	12 Months	23 Aug 2014	2013-178659
Hewlett Packard	34401A	3146A10352	12 Months	3 Sep 2014	6214490
PCB	1502C02FJ15PSIA	1429	12 Months	2 Oct 2014	3463562606
Larson Davis	PRM915	0112	12 Months	9 Oct 2014	2013-180644
Larson Davis	2900	0661	12 Months	7 Apr 2015	2014-189102

Reference Standards are traceable to the National Institute of Standards and Technology (NIST)

Calibration Environmental Conditions

Environmental test conditions as shown on calibration report.

Affirmations

This Certificate attests that this instrument has been calibrated under the stated conditions with Measurement and Test Equipment (M&TE) Standards traceable to the U.S. National Institute of Standards and Technology (NIST). All of the Measurement Standards have been calibrated to their manufacturers' specified accuracy / uncertainty. Evidence of traceability and accuracy is on file at Provo Engineering & Manufacturing Center. An acceptable accuracy ratio between the Standard(s) and the item calibrated has been maintained. This instrument meets or exceeds the manufacturer's published specification unless noted.

The collective uncertainty of the Measurement Standard used does not exceed 25% of the applicable tolerance for each characteristic calibrated unless otherwise noted.

The results documented in this certificate relate only to the item(s) calibrated or tested. A one year calibration is recommended, however calibration interval assignment and adjustment are the responsibility of the end user. This certificate may not be reproduced, except in full, without the written approval of the issuer.

Before: 114.08 dB, 94.08 dB, 1000.2 Hz @ sea level.
After: Refer to Certificate of Measured Output.

Signed: Scott Montgomery
Technician: Scott Montgomery

Page 1 of 1

Provo Engineering and Manufacturing Center, 1681 West 820 North, Provo, Utah 84601
Toll Free: 888.258.3222 Telephone: 716.926.8243 Fax: 716.926.8215
ISO 9001-2008 Certified

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Larson Davis CAL200 Acoustic Calibrator, SN: 2239
Certificate of Measured Output

Performance at Reference Conditions

Nominal Level (dB SPL):	94	114
Measured Level (dB SPL):	**93.98**	**113.99**
Expanded Uncertainty (dB):	0.137	0.135
Level Error Limit (dB):	±0.34	±0.33
Nominal Frequency (Hz):	1000	1000
Measured Frequency (Hz):	**1000.2**	**1000.2**
Expanded Uncertainty (Hz):	0.2	0.2
Frequency Error Limit (Hz):	±10.0	±10.0
Measured Distortion (%):	0.38	0.37
Expanded Uncertainty (%):	0.25	0.25
Distortion Limit (%):	2.0	2.0

The data is aquired by the insert voltage calibration method using the reference microphone's open circuit sensitivity.

Environmental Conditions

Temperature (°C):	24	24
Relative Humidity (%):	33	33
Static Pressure (kPa):	101.2	101.3

Reference Microphone
Model: Larson Davis 2559
Serial Number: 2506
Open Circuit Sensitivity: 12.230 mV/Pascal
Uncertainty: 0.110 dB

Influence of Static Pressure
Nominal Level (dB SPL): 114

Nominal Pressure (kPa)	Pressure (kPa)	Level Change (dB)	Frequency Change (Hz)	Distortion (%)
108.0	108.1	-0.03	0.00	0.37
101.3	101.3	0.00	0.00	0.37
92.0	92.2	0.02	0.00	0.39
83.0	83.1	0.01	-0.00	0.41
74.0	74.0	-0.05	-0.01	0.44
65.0	64.9	-0.18	-0.01	0.47
Expanded Uncertainty:	1.0	0.04	0.20	0.25
Limit:		±0.30	±10.0	2.0

Reference microphone corrections applied.

Environmental Conditions
Temperature (°C): 25
Relative Humidity (%): 34

Reference Microphone
Model: Larson Davis 2559
Serial Number: 2506

Static pressure was measured with a calibrated Motorola pressure sensor MPX2100AP.
Temperature and humidity was measured with a calibrated Fluke 1620A sensor.
Expanded uncertainty of environmental measurements: 0.3 °C, 3 %RH, 1.0 kPa
Uncertainty values are given at 95% confidence level (k = 2).

A Sound Level Meter can be calibrated to a level (L) defined as: L = measured level + pressure sensitivity or if a Sound Level Meter is calibrated using the nominal level, the adjustments to data (X) are defined as: X = measured level - nominal level - pressure sensitivity

Scott Montgomery — Larson Davis Calibrator Calibration System — 04 / 18 / 2014