Appendix G Noise

Crystal Springs Uplands School
8-10 Davis Drive, Belmont, CA 94002
Appendix D: Noise Data Summary (raw data available upon request)
Prepared by MIG|TRA Environmental Sciences, April 2015

Table D1: Summary of Site LT-5 Noise Monitoring Data

Site 1 (100 feet from the northern boundary of the project area)									
Date	Time	Leq	Ldn	Lmax	Lmin	L(10)	L(25)	L(50)	L(90)
17Mar 15	12:00:00	No Data Available							
17Mar 15	13:00:00	47	47	69	39	49	46	44	41
17Mar 15	14:00:00	48	48	69	39	50	46	43	41
17Mar 15	15:00:00	50	50	69	39	50	47	44	41
17Mar 15	16:00:00	48	48	66	39	50	47	44	41
17Mar 15	17:00:00	49	49	66	41	52	48	46	43
17Mar 15	18:00:00	49	49	69	41	52	48	45	43
17Mar 15	19:00:00	48	48	69	40	49	45	43	41
17Mar 15	20:00:00	50	50	71	40	53	48	44	42
17Mar 15	21:00:00	48	48	69	40	51	46	43	41
17Mar 15	22:00:00	45	55	67	38	48	43	41	39
17Mar 15	23:00:00	41	51	59	37	42	40	39	37
18Mar 15	0:00:00	39	49	59	37	40	38	38	37
18Mar 15	1:00:00	38	48	53	36	39	38	37	36
18Mar 15	2:00:00	37	47	48	36	38	37	37	36
18Mar 15	3:00:00	37	47	44	36	38	37	37	36
18Mar 15	4:00:00	37	47	43	36	38	37	37	36
18Mar 15	5:00:00	41	51	59	37	42	40	39	38
18Mar 15	6:00:00	45	55	58	40	47	45	43	41
18Mar 15	7:00:00	47	47	60	41	49	46	45	43
18Mar 15	8:00:00	46	46	62	40	49	46	44	42
18Mar 15	9:00:00	47	47	59	39	50	47	44	40
18Mar 15	10:00:00	46	46	69	39	48	45	43	41
18Mar 15	11:00:00	51	51	74	38	48	44	41	39
18Mar 15	12:00:00	44	44	44	44	44	44	44	44
Site LT-5 Average		***47***	***49***	***74***	***36***	***48***	***45***	***43***	***40***

Notes: Hourly values based on 15-minute interval measurement periods.
All hourly values based on 60 minutes of monitoring, except 17Mar15 12:00:00.
Data readings for this hour were not included due to operator error during setup

Table D2: Summary of Site LT-6 Noise Monitoring Data

Site LT-6 (265 feet from the northern boundary of the project area)									
Date	Time	Leq	Ldn	Lmax	Lmin	L(10)	L(25)	L(50)	L(90)
17Mar 15	12:00:00	No Data Available							
17Mar 15	13:00:00	50	50	73	39	63	54	46	41
17Mar 15	14:00:00	50	50	70	40	54	48	45	42
17Mar 15	15:00:00	53	53	83	40	52	48	46	43
17Mar 15	16:00:00	48	48	66	39	51	48	44	41
17Mar 15	17:00:00	48	48	74	39	49	47	45	42
17Mar 15	18:00:00	47	47	63	39	49	47	45	42
17Mar 15	19:00:00	47	47	63	39	48	46	45	42
17Mar 15	20:00:00	45	45	61	39	47	45	43	41
17Mar 15	21:00:00	44	44	57	39	46	44	42	40
17Mar 15	22:00:00	43	53	55	38	45	43	41	39
17Mar 15	23:00:00	40	50	53	37	42	41	39	38
18Mar 15	0:00:00	39	49	51	37	40	39	38	37
18Mar 15	1:00:00	38	48	47	37	40	38	38	37
18Mar 15	2:00:00	38	48	50	36	39	38	38	37
18Mar 15	3:00:00	38	48	48	36	40	39	38	37
18Mar 15	4:00:00	38	48	45	36	38	38	38	37
18Mar 15	5:00:00	39	49	50	37	41	40	39	38
18Mar 15	6:00:00	43	53	54	39	45	43	42	40
18Mar 15	7:00:00	46	46	58	39	48	46	45	42
18Mar 15	8:00:00	46	46	57	40	48	46	45	43
18Mar 15	9:00:00	51	51	82	40	49	47	45	43
18Mar 15	10:00:00	49	49	66	41	51	48	46	44
18Mar 15	11:00:00	52	52	74	39	48	46	44	41
18Mar 15	12:00:00	46	46	46	46	46	46	46	46
Site LT-6 Average		**47**	**49**	**83**	**36**	**51**	**46**	**43**	**41**

Notes: Hourly values based on 15-minute interval measurement periods.
All hourly values based on 60 minutes of monitoring, except 17Mar15 12:00:00.
Data readings for this hour were not included due to operator error during setup

WILSON IHRIG & ASSOCIATES
ACOUSTICAL AND VIBRATION CONSULTANTS

CALIFORNIA NEW YORK WASHINGTON

6001 SHELLMOUND STREET
SUITE 400
EMERYVILLE, CA 94608
Tel: 510-658-6719
Fax: 510-652-4441
www.wiai.com

CRYSTAL SPRINGS UPLANDS SCHOOL BELMONT

NOISE STUDY REPORT
FINAL

15 December 2011

Corrections provided 2 July 2012

Prepared for
Luce, Forward, Hamilton & Scripps LLP
121 Spear Street
Suite 200
San Francisco, CA 94105

Prepared by

Wilson, Ihrig & Associates, Inc.

Leisa E. Nalls
Associate Consultant

Deborah A. Jue
Principal

Pablo A. Daroux
Principal

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1 INTRODUCTION AND SUMMARY

Crystal Springs Uplands School (CSUS) located in Hillsborough, California since 1952, intends to build a new middle school in Belmont, California (Proposed Project), in order to expand its educational offerings to a wider base of families. With this new campus, CSUS would double its middle school (grades 6-8) enrollment from its current size of about 100-110 students to approximately 220 students, with an anticipated maximum capacity of 240 students.

The purpose of this noise study is to evaluate the potential noise impacts in order to guide the Proposed Project's design process, to provide information regarding potential noise effects on nearby sensitive receptors, and to identify possible noise control techniques that could be integrated into the project to ensure compliance with local noise ordinances and noise impact criteria.

This corrected report provides the correct information for Figure 2-10 through Figure 2-13 and corrections to Table 4-3. No updates to the Amphitheater analysis have been made; it is no longer included in the Project.

1.1 PROJECT DESCRIPTION

The Proposed Project area is a 6.5-acre site at 8 and 10 Davis Drive that would allow CSUS to build approximately 50,000 square feet of new building area, including an academic center with classrooms and administrative space, a café building, and a gymnasium. The flat site also would allow CSUS to build a soccer field, and in the future, CSUS intends to build a swimming pool with adjoining locker rooms and an amphitheater along the natural slope at the southwest corner of the site.

The demolition phase for the Proposed Project is expected to begin in January 2013 and is anticipated to take two to three months. Two existing buildings totaling 56,300 square feet will be demolished and approximately 80,000 square feet of paved parking and hardscape area will be removed. Equipment on site would include one excavator with hoe-ram and crusher attachments, two loaders, one water trucks, one dozer and one scraper. For the debris, it will take about 35 trips for a 10-yard dump truck to haul demolition debris from the site; the remainder of material will be recycled.

Construction is set to begin upon completion of demolition, likely the spring (March) of 2013, and continue for 14 months (end of construction is anticipated to be June 2014). Approximately 50,000 of total square footage of building would be constructed. The anticipated phases and equipment are as follows:

- Foundations and building undergrounding work would take approximately 18 weeks to complete. Backhoes and concrete trucks would be required for this phase.
- Steel erection and structural deck slab construction would take approximately two months. A 160-ton mobile crane would be needed for steel, stairs and decking and other heavy building components. It is expected the crane would be onsite for about 6 months.
    - Several JLG-type telehandlers and forklifts would be utilized for moving and lifting building materials and would be on site for most of the 14-month

construction period. A water truck would also be onsite for most of the construction period for dust control.

  - Exterior walls, roofing and remaining exterior building work would take approximately 3 months to complete.

- Undergrounding of utilities and repaving the site would require approximately 12 weeks. Undergrounding of utilities would require approximately four weeks. Equipment that would be used includes one excavator and loader, two dump trucks and one compactor.

- Final site preparation phase is expected to take about 3 months. A grader would be used for spreading and leveling soil along with soil compactors. Street sweepers would clean up at the end of the day to ensure mud and dirt are not pulled out onto the city streets.

- Construction staging - Crystal Springs Uplands School has arranged with a property owner to the east of the 10 Davis Drive site to use the vacant building as a construction office for the General Contractor's project offices. Work would not begin until 8AM weekdays and would be complete by 5 PM as required by the City of Belmont.

Construction staffing would consist of a maximum of about 15 -20 people on site during the abatement and demolition phases. Construction phase staffing would begin with about 30-40 people coming to the site. At the peak of construction--when interior finishing is being done--there would be approximately 100 people on site. Toward the completion of construction, the numbers coming to site would reduce to about 20 people.

1.2 SUMMARY

The noise impacts from the proposed Project are as follows:

- The Proposed Project and the existing noise environment would be compatible with the land use policies.

- Sounds from the pool area (starter air horns) would potentially exceed the Belmont Noise Ordinance at the Lutheran Day School. With the recommended noise control measures, the Proposed Project operations would comply with local planning policies and the noise ordinance.

- The Proposed Project demolition and construction activities would cause temporary noise impacts at the Ralston Middle School due to potential speech interference effects, which could cause a temporary substantial noise increase. A temporary sound barrier constructed along the property line between the Proposed Project and the Ralston Middle School and demolition phasing strategies would eliminate the noise impact.

Appendices A and B contain a discussion of acoustics and terms relevant to an environmental noise analysis, respectively.

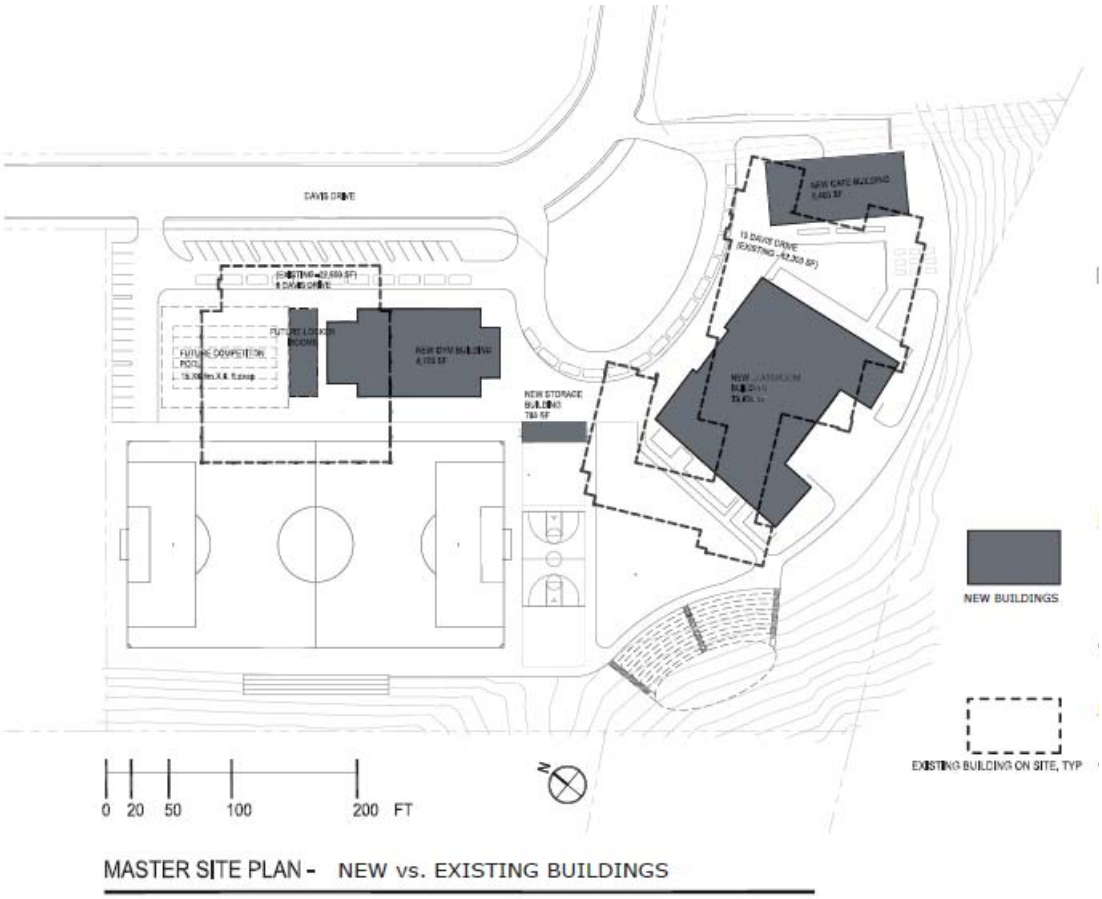

Figure 1-1 Project Site Map

2 SETTING: EXISTING NOISE ENVIRONMENT

The Proposed Project would be located within the city of Belmont, CA. The surrounding community consists mostly of residential uses and open spaces, with a few commercial or industrial areas. The dominant noise source is Ralston Avenue, with additional noise contributed by plane traffic from San Francisco International Airport (SFO) and activities on the Ralston Middle School athletic fields. The project is not located within the noise contours for SFO, however, it is within the general flight patterns and noise generated by planes is audible at the project.

The nearest, noise sensitive receptors are Ralston Middle School, located approximately 670 feet from the project at 2675 Ralston Avenue in Belmont, and several buildings affiliated with the Gloria Dei Lutheran Elementary School, located approximately 680 feet from the Proposed Project at 2600 Ralston Avenue in Belmont; There are several other residences north of Ralston which would be shielded from the Proposed Project by the topography..

2.1 DESCRIPTION OF NOISE MEASUREMENT LOCATIONS

In September, 2011, WIA conducted measurements of the existing noise environment at four locations adjacent to the Proposed Project. These locations (shown in Figure 2-1) were selected to document the noise environments at receptors[1] near the Proposed Project, which could already be affected by an increase in noise levels over current conditions. Generally, the measurement locations were selected at areas where the receptors are close to the Proposed Project and would potentially experience the highest noise exposure from it.

Noise was measured over a ten day period from 9 September to 19 September 2011 at sensitive receptors (sensitive areas, schools, residences, etc) while the Ralston Middle School was in session. To our knowledge, the noise environment measured during the survey was consistent with normal ambient conditions in this area. This long-term noise survey was conducted with battery-operated noise level meters, which continuously measured the noise level and stored the equivalent noise level (Leq) every hour. The measurement locations are described below as illustrated in Figure 2-1.

A fifteen minute short-term noise measurement was also taken at the Proposed Project site to provide direct observation of local noise sources.

Location LT-1 Noise measurement Location 1 was sited approximately 1,840 feet southwest of the Proposed Project. The long-term noise monitor was mounted on a tree at a height of approximately 12 feet, along the hiking trail at the west end of the canyon. The primary source of ambient noise at location LT-1 is hiking trail use. This measurement location documents the typical environment for homes with backyards facing the Proposed Project.

Location LT-2 Noise measurement Location 2 was sited approximately 70 feet west of the Proposed Project. The long-term noise monitor was mounted on a tree at a height of approximately 10 feet, at the easternmost corner of the Ralston Middle School athletic field. The

[1] The term "receptors" refers to the land use that would experience or receive the noise generated by the project. Land use that is potentially sensitive to noise from construction activities is considered a "sensitive receptor" and includes residential, school, medical, hotel, office, and, in some cases, commercial or industrial uses.

primary sources of ambient noise at location LT-2 are traffic on Ralston Avenue and outdoor activities at Ralston Middle School. The School was in session during the noise survey.

Location LT-3 Noise measurement Location 3 was sited approximately 410 feet north of the Proposed Project. The long-term noise monitor was mounted on a utility pole at a height of approximately 12 feet, on Ralston Avenue near the intersection with Davis Drive. The primary source of ambient noise at location LT-3 is traffic on Ralston Avenue.

Location LT-4 Noise measurement Location 4 was sited approximately 10 feet south of the Proposed Project. The long-term noise monitor was mounted on a tree, at a height of approximately 10 feet, on the downward slope of the canyon edge by the south edge of the property. The primary sources of ambient noise at location LT-4 are hiking trail use and outdoor activities at Ralston Middle School.

Location ST-1 A 15-minute noise measurement was taken at a height of 5 feet, approximately 30 feet north from site LT-4, on the project property on September 9, 2011 at 4:45 pm. The primary sources of ambient noise observed at location ST-1 were plane flyovers, hiking trail use and outdoor activities at Ralston Middle School.

2.2 MEASUREMENT RESULTS – NOISE

Error! Reference source not found. summarizes the results of the noise survey, and Figure 2-2 to Figure 2-5 illustrate the hourly variation in equivalent noise levels at each long-term measurement location.

The noise measurements indicate that the existing noise environments are relatively quiet. The noise environment at the Davis Drive site is dominated by afterschool outdoor activities at the adjacent Ralston Middle School. Those areas directly along Ralston Avenue are typical of traffic-dominated noise environments in an urban setting, with low noise levels during the early morning hours, increased noise during the morning commute, a possible lessening of noise during the mid-day hours, an afternoon commute, and a lessening of noise during the evening. The existing daytime noise environment near most sensitive receptors is well below 60 dBA Leq, and with the exception of Location 3, adjacent to Ralston Avenue, the existing day-night noise exposure level was below 55 Ldn and consistent with the “normally acceptable” noise environment for residential and school land use outlined in the Noise Element of the Belmont General Plan The exception is the area along Ralston Avenue, where homes and a school are exposed to noise exceeding 70 Ldn, which places that area in the “normally unacceptable” category. Along Ralston Avenue, the daytime noise level exceeds 70 dBA Leq and the nighttime noise exceeds 60 dBA Leq, but in most areas represented by noise measurement locations LT-1, LT-2 and LT-4, the nighttime noise is expected to be 50 Leq or less, as is typical of urban environments (see Appendix A).

Figure 2-6 to Figure 2-9 illustrate the existing maximum hourly noise levels, as indicated by the maximum noise level measured each hour (Lmax). Since these were un-attended measurements, the source of the maximum noise levels are not always verifiable, and sometimes they are caused by birds singing near the equipment, wind, leaves, etc. For this reason, when characterizing a noise environment in which different individual sources contribute to the environment, the typical maximum noise level is often interpreted from the statistical data obtained during a noise survey, as discussed below. The noise measurements indicate that the existing Lmax noise levels are often between 60 and 70 dBA during the daytime hours, with the exception of location LT-2 along Ralston Avenue, which reaches 80 to 90 dBA and greater during the daytime hours. Along

Ralston Avenue, the hourly Lmax nighttime noise exceeds 75 dBA, but in most areas, the hourly Lmax nighttime noise is expected to be 60 dBA or less.

Figure 2-10 to Figure 2-13 illustrate the existing maximum hourly noise levels, as indicated by the L10 metric. The L10 metric corresponds to the noise level exceeded 10% of the time based on the time history logged during the noise measurements, and it is a useful tool to characterize frequently occurring maximum noise events in the environmental noise. The noise measurements indicate that the existing Lmax noise levels are typically below 60 dBA during the daytime hours, with the exception of location LT-2 along Ralston Avenue, which is at roughly 75 dBA during the daytime hours. Along Ralston Avenue, the typical Lmax nighttime noise exceeds 60 dBA , but in most areas, the typical Lmax nighttime noise is expected to be 50 dBA or less.

Table 2-1 Summary of Existing Noise Levels (September 2011)

Noise Measurement Location	Nearby Street/City	Land Use	Noise (dBA)[2]			Noise Environment / Comments
			Ldn	Typical Daytime Leq	Typical Nighttime Leq	
1	Lassen Dr. Belmont	O / R	48	46	40 – 46	Trail Use
2	Davis Dr. Belmont	C	53	52	44 – 49	School / Athletic Fields
3	Ralston Ave. Belmont	C/R	72	72	63 – 69	Ralston Ave.
4	Davis Dr. Belmont	C	48	48	38 - 47	Trail Use, School / Athletic Fields

R= primarily residential land use, C= primarily commercial land use , C/R= mixed use, or commercial at test well Site, *with Residential land use nearby*, O= open land

Figure 2-1 **Aerial View of Project Site and Noise Monitor Locations**

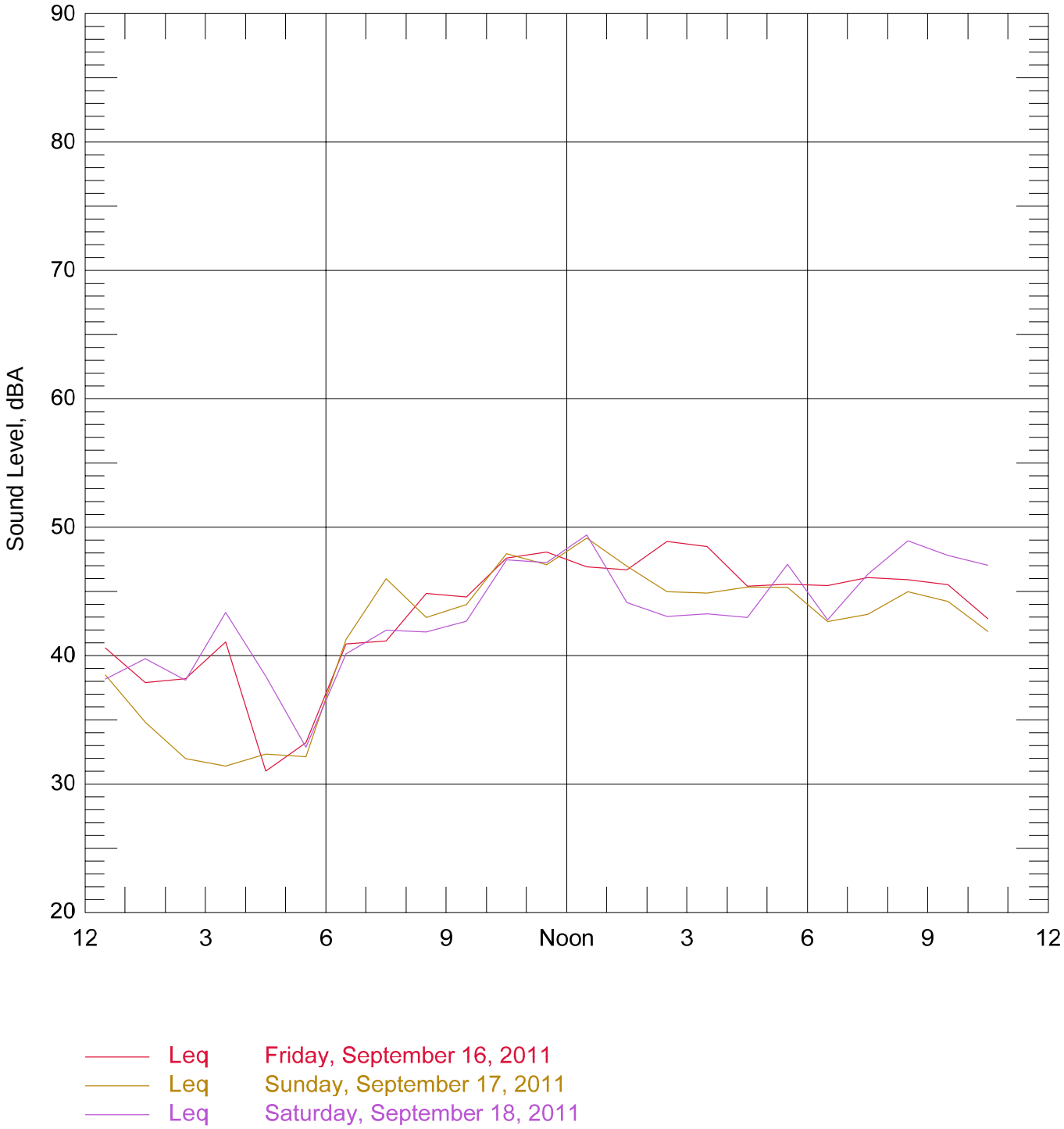

Figure 2-2 Summary of Hourly Equivalent Noise Levels (Leq), Location LT-1 Along Hiking Trail, On Tree 16 September to 18 September 2011

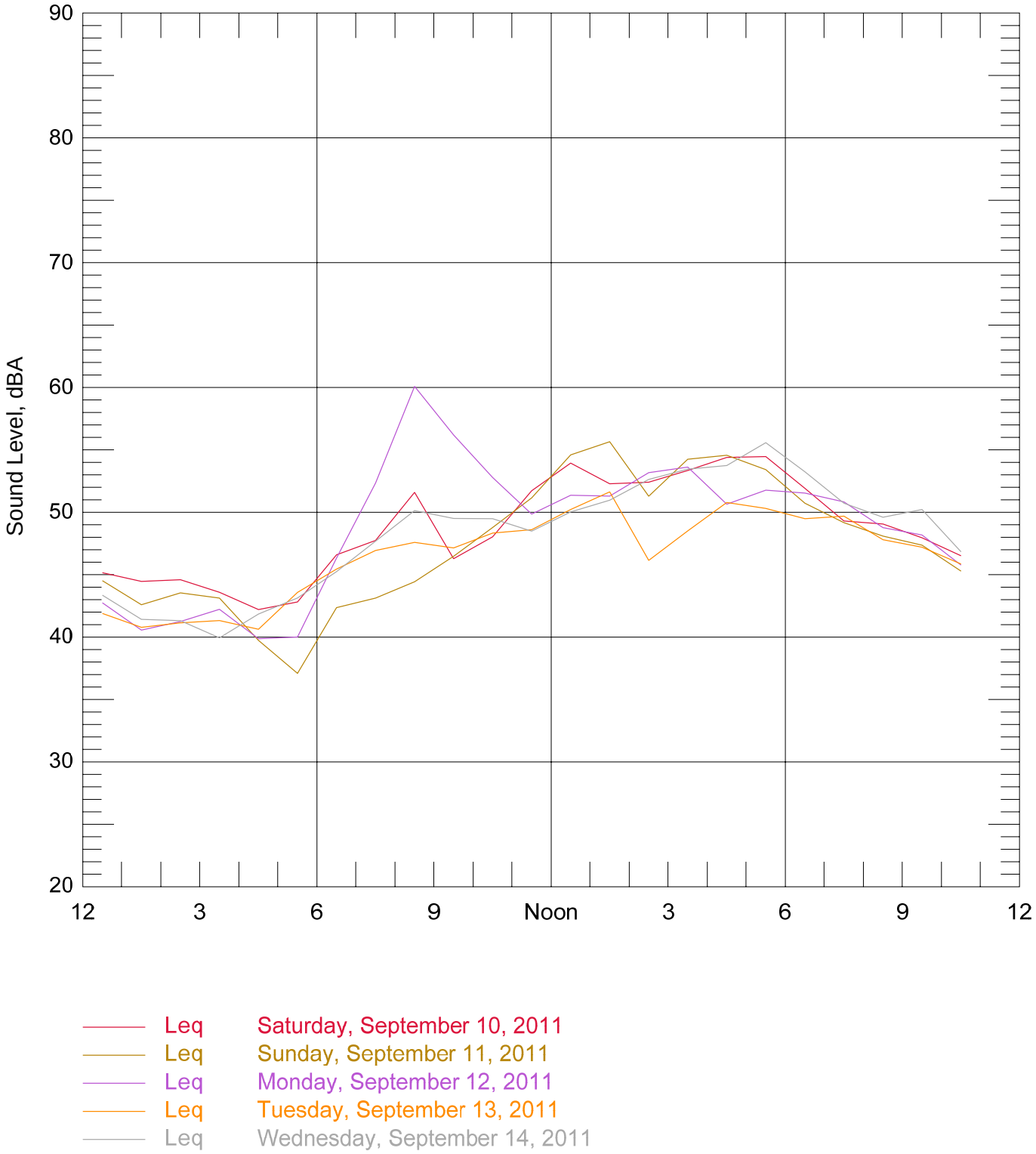

Figure 2-3 Summary of Hourly Equivalent Noise Levels (Leq), Location LT-2 Adjacent to Ralston Middle School Athletic Field, On Tree 10 September to 14 September 2011

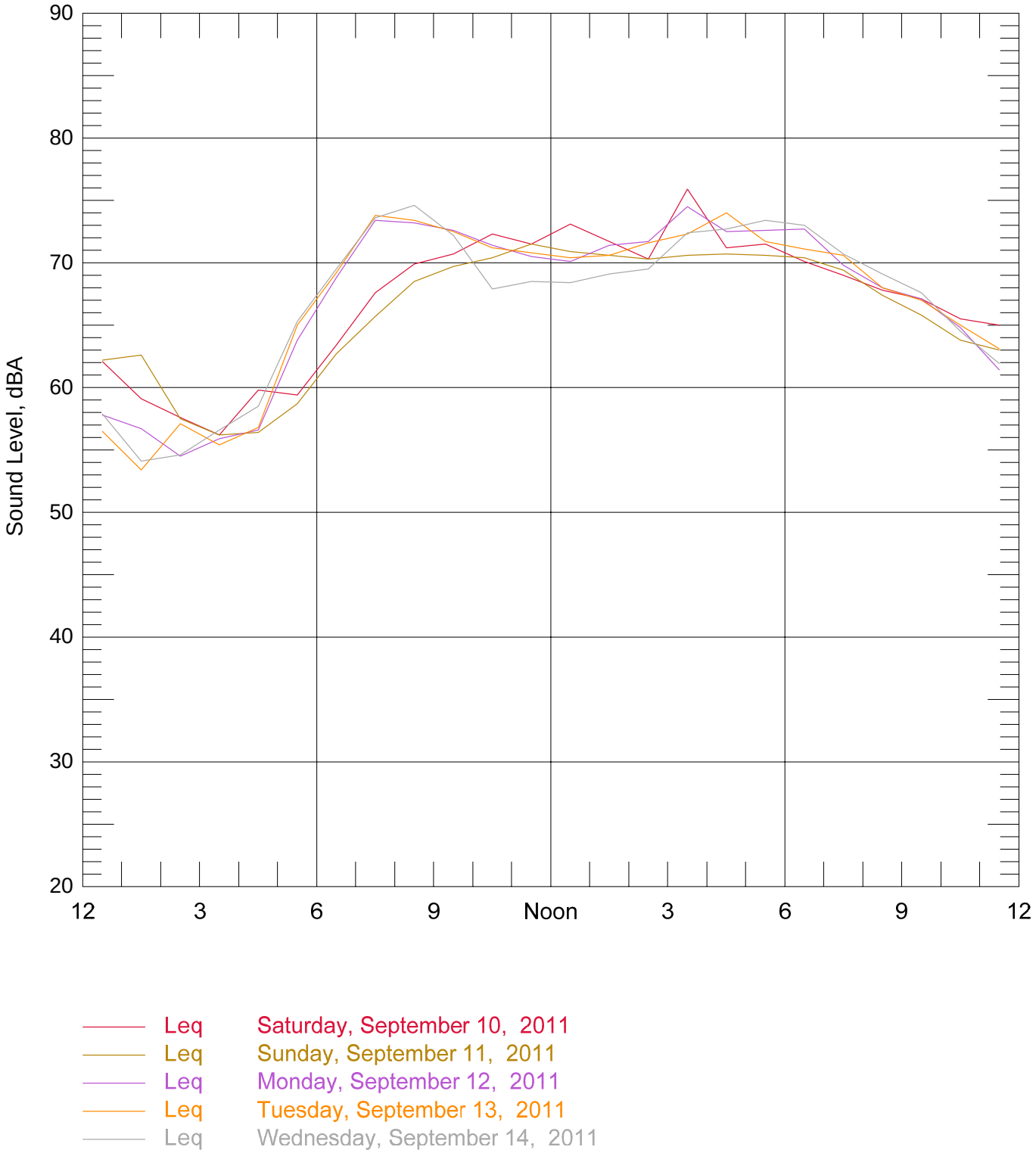

Figure 2-4 Summary of Hourly Equivalent Noise Levels (Leq), Location LT-3 Ralston Avenue, On Utility Pole 10 September to 14 September 2011

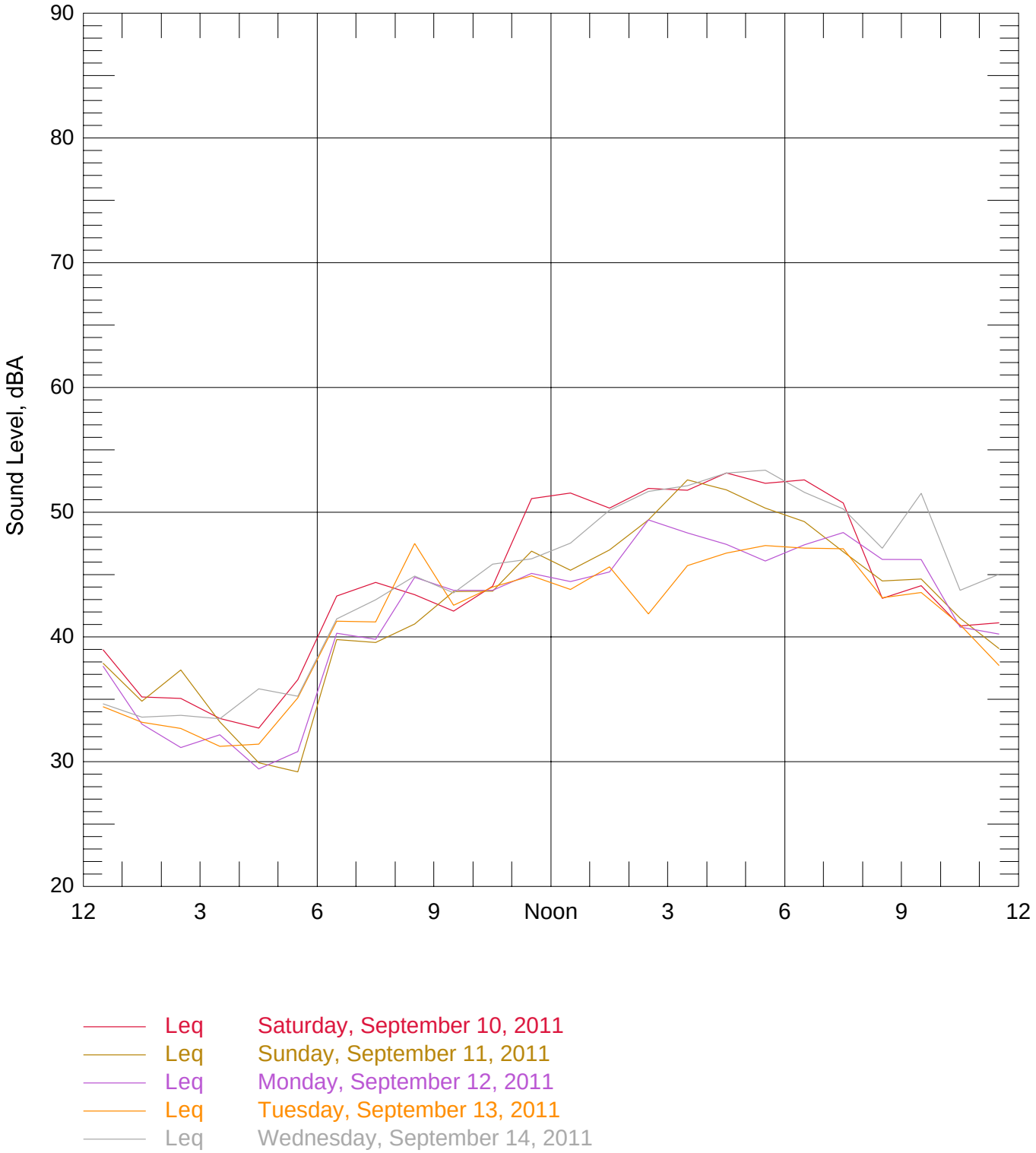

Figure 2-5 Summary of Hourly Equivalent Noise Levels (Leq), Location LT-4 At Canyon Rim by Existing Building on Project Site, On Tree 10 September to 14 September 2011

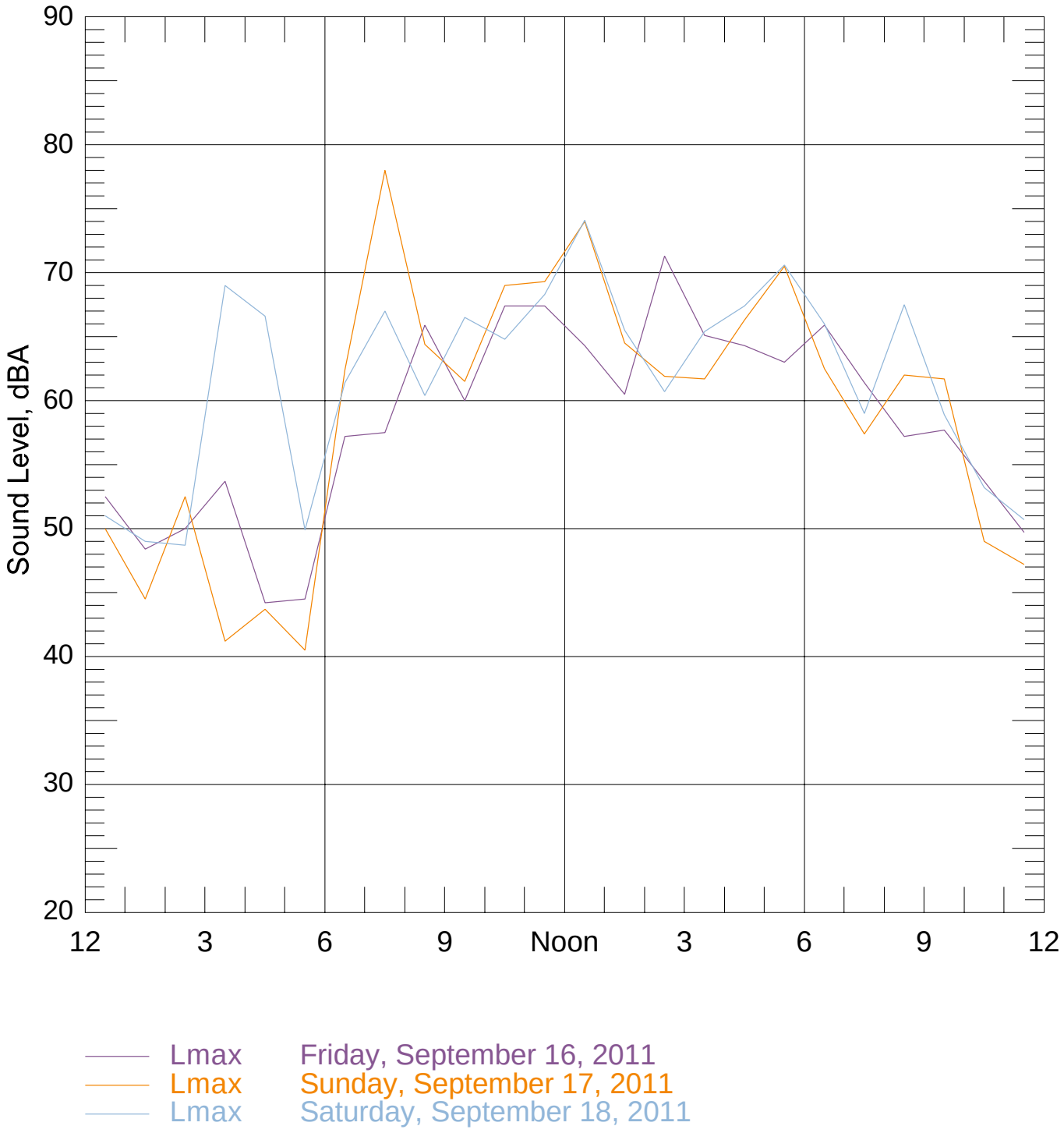

Figure 2-6 Summary of Hourly Maximum Noise Levels (Lmax), Location LT-1 Along Hiking Trail, On Tree 16 September to 18 September 2011

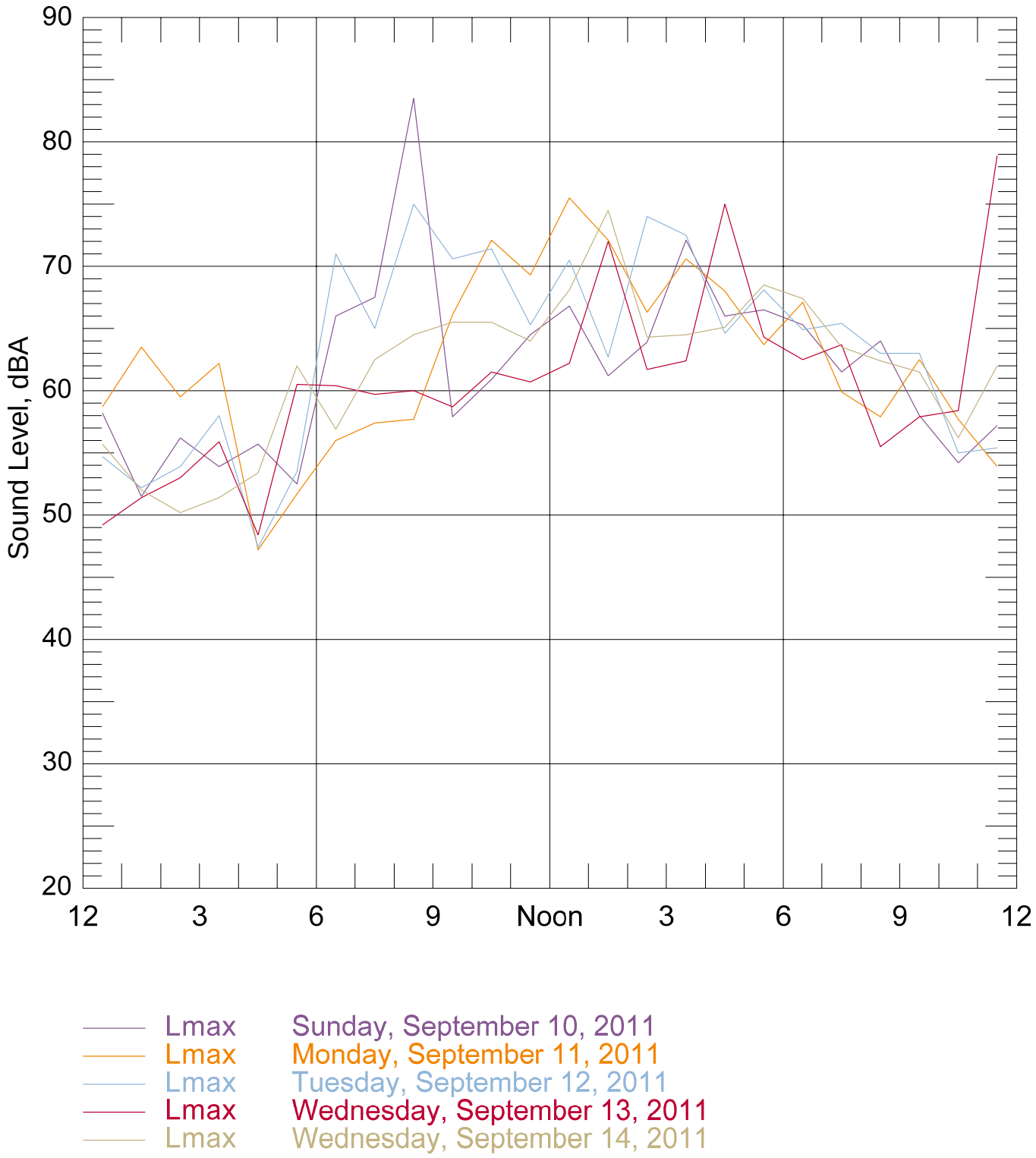

Figure 2-7 Summary of Hourly Maximum Noise Levels (Lmax), Location LT-2 Adjacent to Ralston Middle School Athletic Field, On Tree

10 September to 14 September 2011

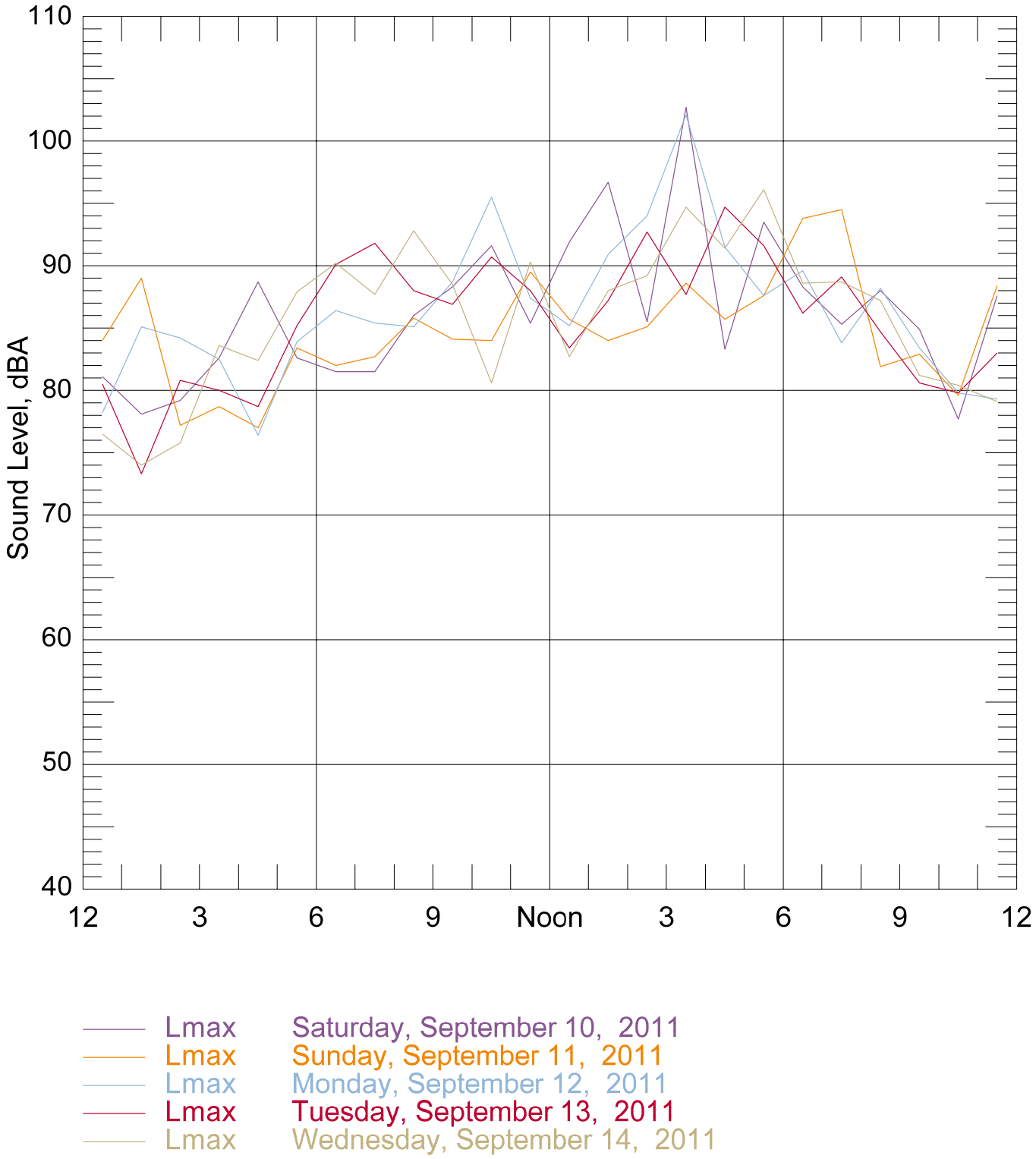

Figure 2-8 Summary of Hourly Maximum Noise Levels (Lmax), Location LT-3 Ralston Avenue, On Utility Pole 10 September to 14 September 2011

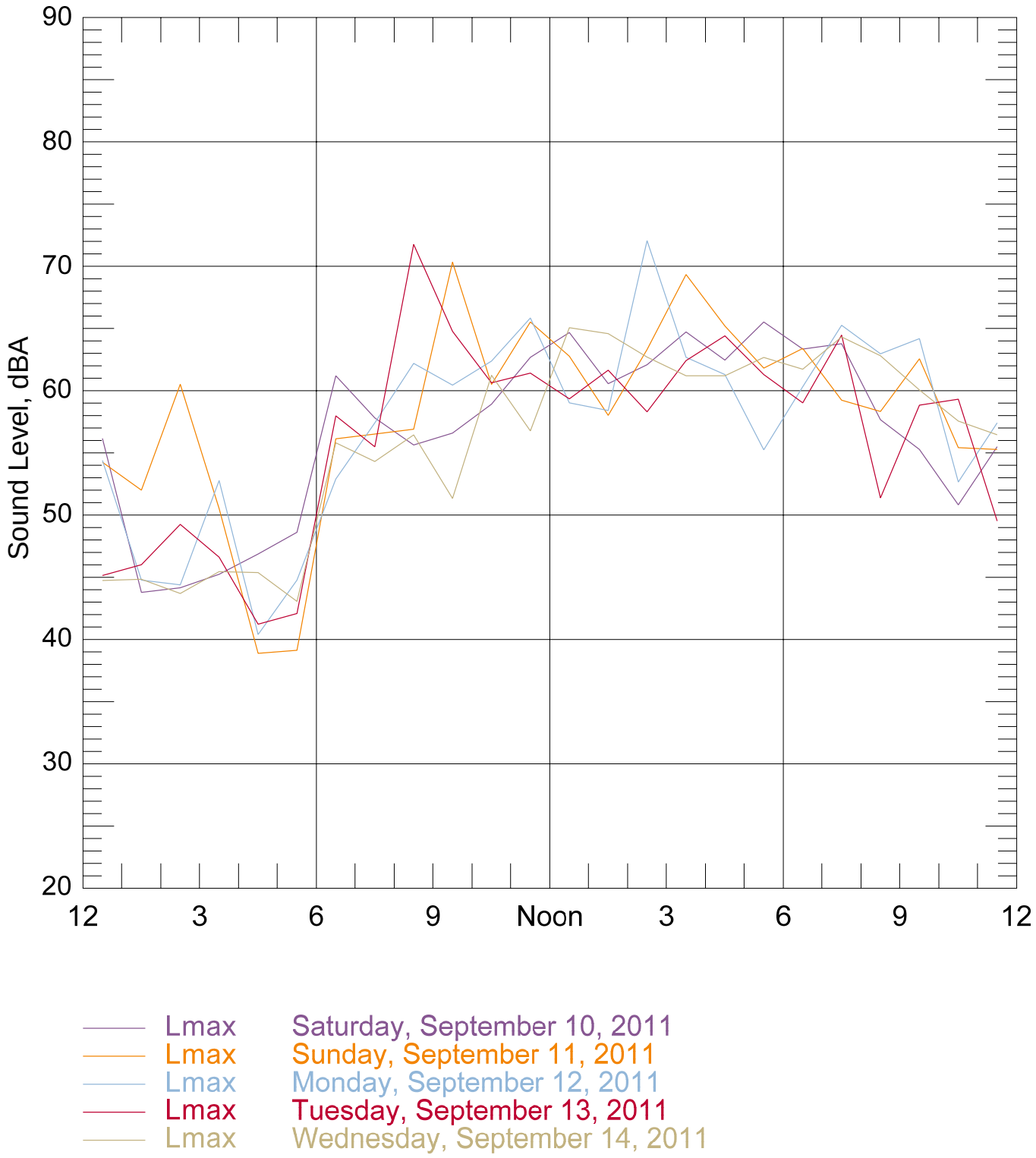

Figure 2-9 Summary of Hourly Maximum Noise Levels (Lmax), Location LT-4 At Canyon Rim by Existing Building on Project Site, On Tree 10 September to 14 September 2011

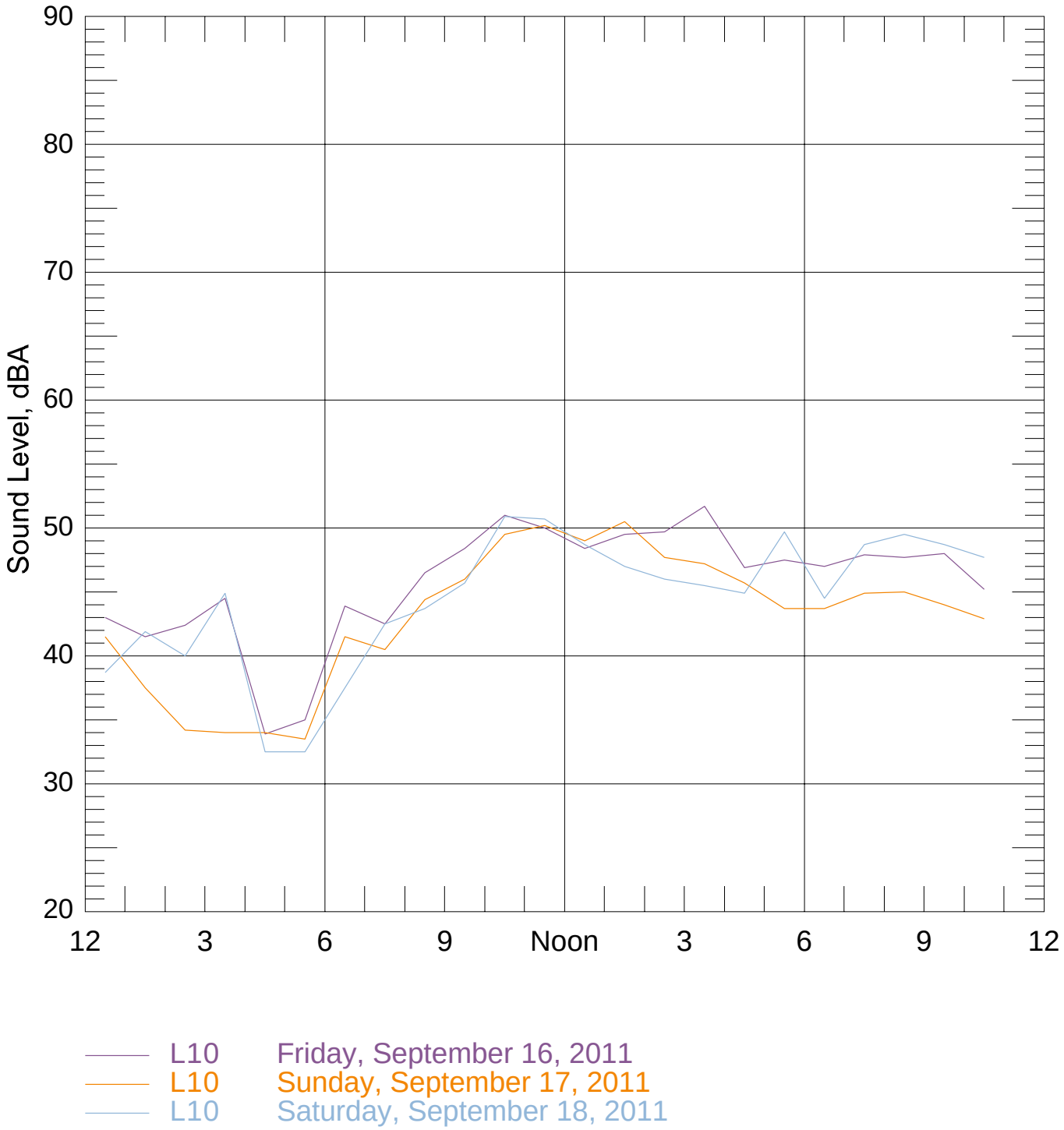

Figure 2-10 Summary of Hourly Typical Maximum Noise Levels (L10), Location LT-1 Along Hiking Trail, On Tree 16 September to 18 September 2011

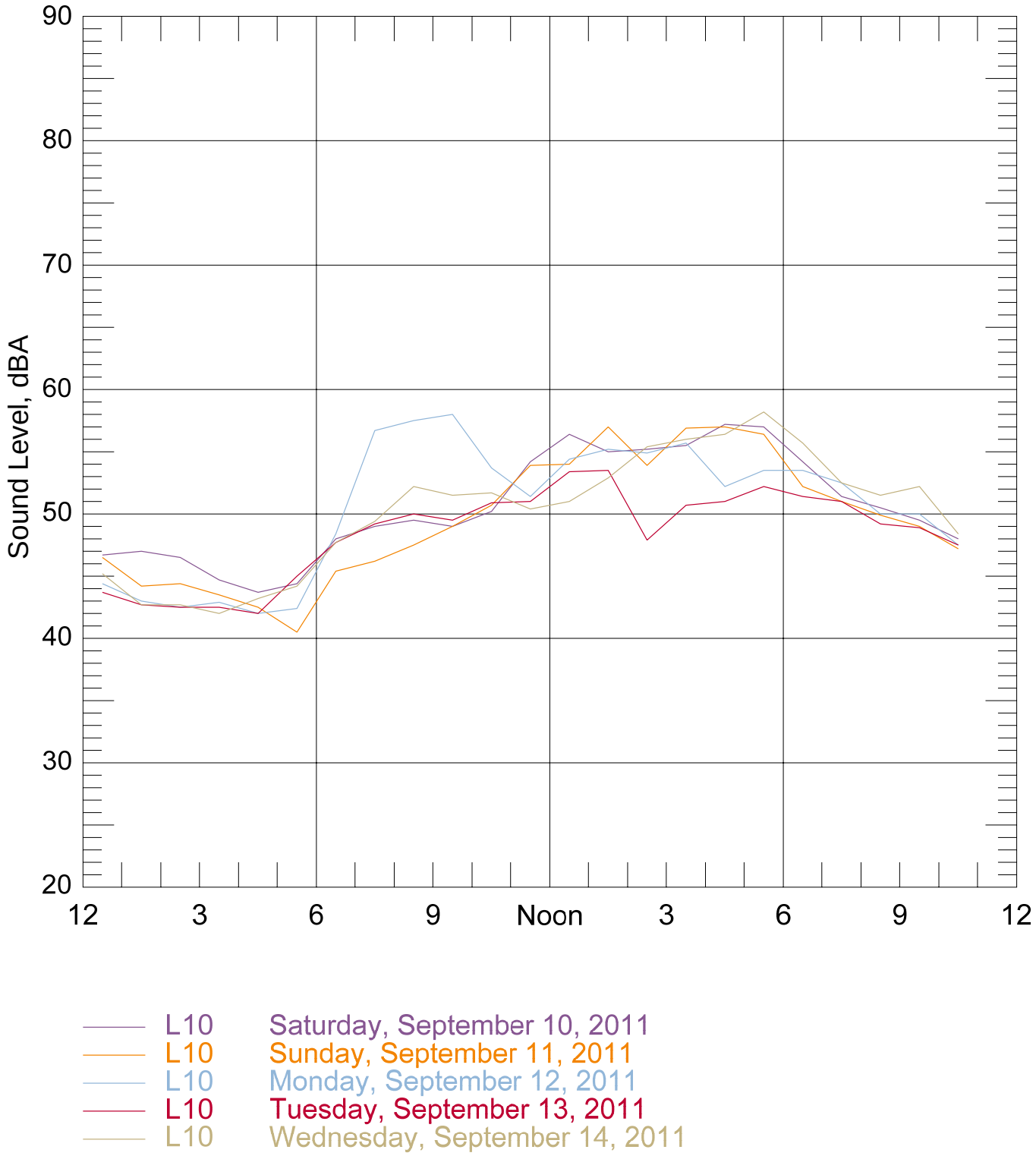

Figure 2-11 Summary of Hourly Typical Maximum Noise Levels (L10), Location LT-2 Adjacent to Ralston Middle School Athletic Field, On Tree 10 September to 14 September 2011

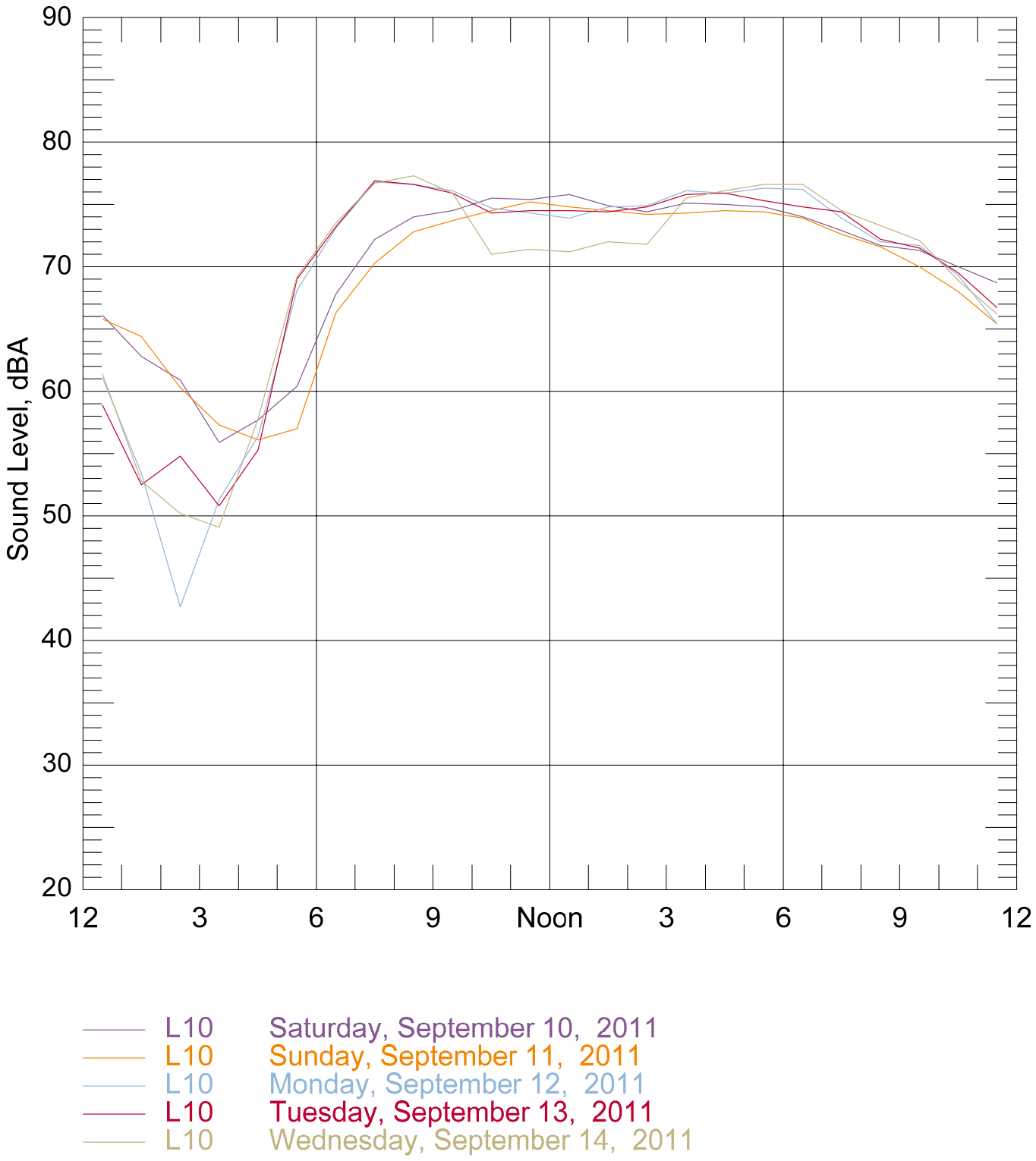

Figure 2-12 Summary of Hourly Typical Maximum Noise Levels (L10), Location LT-3 Ralston Avenue, On Utility Pole 10 September to 14 September 2011

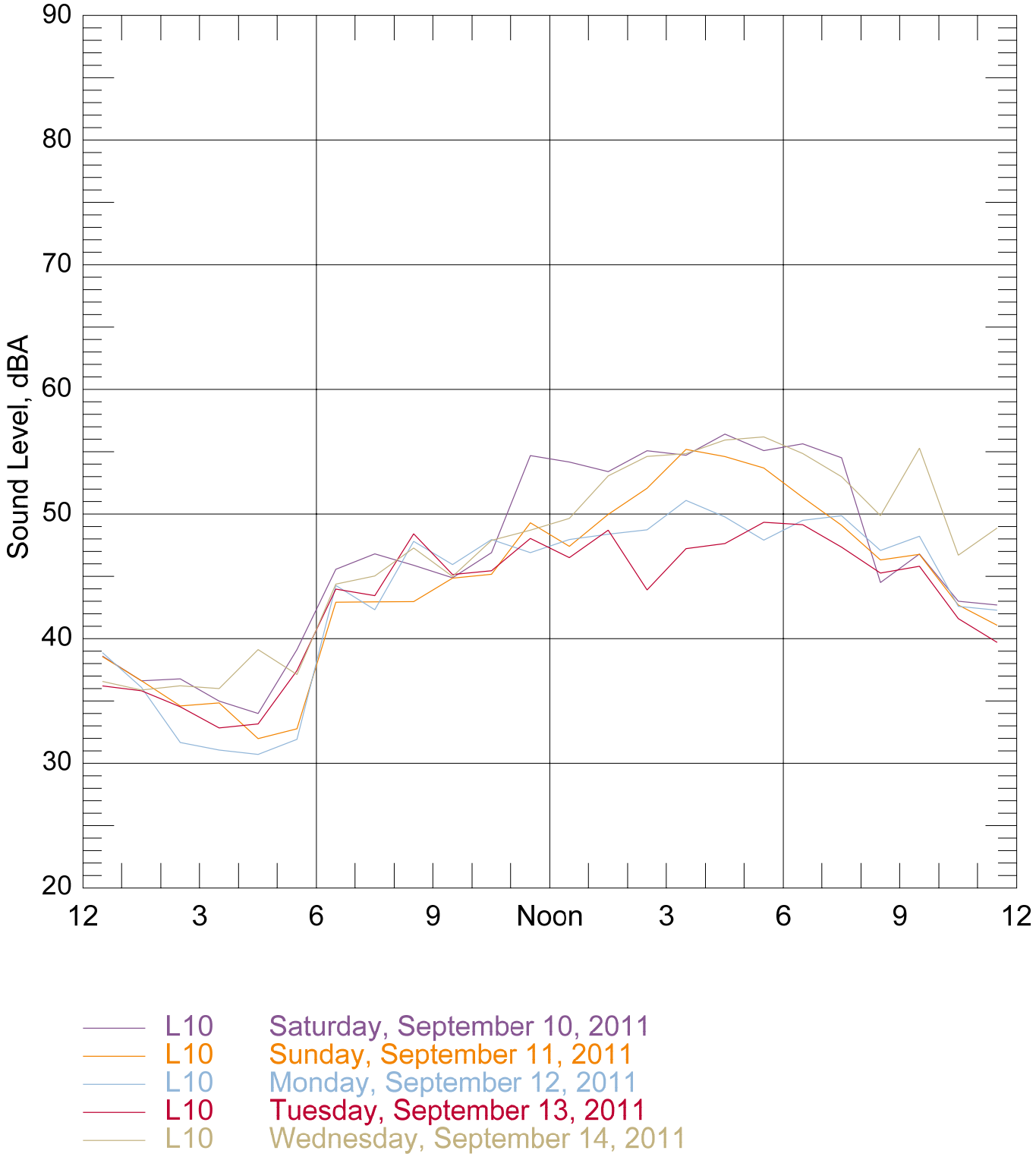

Figure 2-13 Summary of Hourly Typical Maximum Noise Levels (L10), Location LT-4 At Canyon Rim by Existing Building on Project Site, On Tree 10 September to 14 September 2011

3 NOISE CRITERIA

3.1 Airborne Noise Standards (Local)

The following local noise standards are indicated for their applicability or use as guidance to determine the significance criteria under the California Environmental Quality Act (CEQA).

The City of Belmont[2] limits exterior noise sources at the receiving property as noted in Table 3-1 (below). Note that the noise limit is applied according to the character of the noise source; for "continuous" noise sources the Leq is used, and for "repetitive, impulsive" sources the Lmax is used. Construction activities requiring a building permit are limited to the hours of 8 AM to 5 PM Monday through Friday (excluding holidays), 10 AM through 5 PM on Saturdays, and no work allowed on Sundays and holidays. However, temporary use of power equipment is limited to a maximum noise level of 85 dBA at a distance of 50 feet.

For residential land uses, the Belmont Noise Element indicates that an Ldn of less than 60 dBA is "normally acceptable", and that noise insulation measures must be considered when residential land use would be exposed to a noise environment of 54 to 70 dBA (Ldn). For school land use, the "normally acceptable" is 50 to 65 Ldn, with noise insulation measures evaluation required for exposures of 60 to 70 Ldn.

Table 3-1 Belmont Noise Limitations

Source Land Use Category	Time[1]	Noise Level (dB)
From Residential Property	Daytime Nighttime	65 55
From Non-Residential Property	Daytime Nighttime	65 55
Note 1: Daytime is defined as Monday through Friday – 7 AM to 9 PM, Saturday, Sunday and Holidays – 9 AM to 7 PM; Nighttime is defined as any hour outside the defined daytime hours		

[2] Article VIII. Noise Control, Section 15, as accessed via the internet on 9/26/11.

3.2 EVALUATION OF SUBTANTIAL NOISE INCREASE

The CEQA checklist includes an evaluation of a substantial noise increase; the City of Belmont does not appear to have any specific definition for "substantial" nor does it appear to have additional noise evaluation requirements for CEQA.

In this analysis, we propose that a "substantial" noise increase be defined as an increase in noise level to that which a) elevates the noise environment from one acceptability category to the next (i.e., changes from "normally acceptable" to "conditionally acceptable" or "normally acceptable) as noted in the Noise Compatibility Guidelines in the Noise Element or b) causes interference with activities during the day and/or night. One indicator that construction noise could interfere with daytime activities would be speech interference, and an indicator that construction noise could interfere with nighttime activities would be sleep interference. This analysis uses the following criteria to define potential "substantial" noise impacts:

- *Speech Interference*. Speech interference is an indicator of impact on typical daytime and evening activities. A speech interference criterion, in the context of impact duration and time of day, is used to identify substantial increases in noise from temporary construction activities. Typical maximum noise levels generated by construction equipment could result in speech interference in adjacent buildings if the noise level in the interior of the building exceeds 45 to 60 dBA.[3] A typical building can reduce noise levels by 25 dBA with the windows closed (U.S. EPA, 1974). This noise reduction could be maintained only on a temporary basis in some cases, since it assumes windows must remain closed at all times. Assuming a 25 dBA reduction with the windows closed, an exterior noise level of 70 dBA (Leq)[4] at receptors would maintain an acceptable interior noise environment of 45 dBA. It should be noted that such noise levels would be sporadic rather than continuous in nature, because different types of construction equipment would be used throughout the construction process.

- *Sleep Interference*. Based on available sleep criteria data, an interior nighttime level of 35 dBA is considered acceptable (U.S. EPA, 1974). Assuming a 25 dBA reduction with the windows closed, an exterior noise level of 60 dBA at receptors would maintain an acceptable interior noise environment of 35 dBA. Since a 15-dBA reduction would occur with windows open, an exterior noise level of 50 dBA (Leq) would be required to maintain an acceptable interior noise environment of 35 dBA. However, there would be no work conducted during the nighttime hours, as work will be restricted to the 8:00 AM to 5:00 PM window required by the City of Belmont.

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[3] For indoor noise environments, the highest noise level that permits relaxed conversation with 100 percent intelligibility throughout the room is 45 dBA. Speech interference is considered to become intolerable when normal conversation is precluded at 3 feet, which occurs when background noise levels exceed 60 dBA. For outdoor environments, the highest noise level that permits normal conversation at 3 feet with 95 percent sentence intelligibility is 66 dBA (U.S. EPA, 1974).

[4] Since these noise-generating activities would, in aggregate, last no more than two weeks over the 30 to 45-day construction period, the speech interference criterion could be relaxed to 80 dBA (Leq) for intermittent activities and 75 dBA (Leq) for continuous activities, which would still allow for hourly Leq interior environments of 55 and 50 dBA, respectively. These relaxed thresholds would not be applicable to school facilities while in session.

3.3 SUMMARY OF EVALUATION STANDARDS

Table 3-2 summarizes the evaluation thresholds used for this analysis. A noise level which exceeds these thresholds would be considered a significant impact. According to the Belmont Noise Ordinance, the maximum noise level generated by operation of the Proposed Project would be limited to a level of 65 dBA during the daytime hours (evaluated by either Lmax or Leq metric).

Table 3-2 Noise Effect Thresholds Applied To the Project

Noise Source	Permanent or Temporary	Noise Limit (day/night)	Noise Limit Source	Comment
Pool Activities	Permanent	65 dBA/55 dBA Lmax	Belmont Noise Ordinance	Whistles, air horn for races (1)
Ball Field Activities	Permanent	65 dBA/55 dBA Lmax	Belmont Noise Ordinance	Whistles, cheering (1)
Amphitheater	Permanent	65 dBA/55 dBA Lmax	Belmont Noise Ordinance	Applause, cheering (1)
Rooftop Mechanical	Permanent	65 dBA/55 dBA Leq	Belmont Noise Ordinance	Continuous
Demolition and Construction	Temporary	70 dBA/50 dBA Lmax	Substantial Noise Increase Evaluation for CEQA	Intermittent peaks and continuous (1)
Environment	Permanent	Receptors along Ralston: above 75 Ldn Others: above 60 Ldn	Belmont Noise Element	Land use compatibility category change. Up to 60 Ldn is normally acceptable; 60 to 75 Ldn is conditionally acceptable; 70 to 75 is normally unacceptable
Note (1): Since the characteristic nature of this noise source would not be continuous, we have applied the criteria to the Lmax, even though this source would not be “repetitive”, but would occur intermittently throughout the activity.				

4 PROJECT AIRBORNE NOISE

This section identifies the potential permanent and temporary noise effects that would result from construction of the Proposed Project.

This noise evaluation predicts Proposed Project noise levels, evaluates the Proposed Project noise against the noise threshold criteria, and, where indicated, provides recommendations to control the Proposed Project noise through incorporation of design elements to minimize noise effect.

4.1 NOISE PREDICTION METHODOLOGY AND REFERENCE DATA

Operational Noise

The Project noise sources evaluated relate to the operations of the Proposed Project, as follows:

Pool: Noise from whistles, air horns and cheering crowds during practice and swim meets. At this time, the programming of the pool area is not fully defined; therefore it is assumed that meets would be held on periodic weekday afternoons. The sound power levels were used to calculate the sound pressure levels at receptor locations, using the standard rate of sound attenuation (e.g., noise attenuating at 6 dB per doubling distance) as described in the Appendix. Additional noise attenuation is provided by intervening topography and buildings as modeled with SoundPlan. For a typical middle school swim meet it is assumed that there would be roughly 5 races per hour, this assumes that each race lasts no more than 2 minutes with a 5 minute set up time for each race. The spectators are assumed to cheer for at least 15 minutes of any hour during the swim meet. This analysis assumes that swim meets would last a maximum 4 hours.

Noise Source	Reference Level (Sound Power)	Comment
Whistles	106 dBA	Based on sound pressure levels measured at LT-2 from Ralston Middle School athletic field, 50' nominal distance
Air guns/starter device	120 dBA	
Cheering crowds	95 dBA	

Field: Noise from whistles and cheering crowds during practice and ball games. It is intended that the field be available for use by the community, as well as the Proposed Project, therefore, a variety of games could be played on weekday afternoons and weekend days throughout the year. Noise was modeled from whistles during daily physical education classes, up to three classes a day weather permitting. For a typical game it is assumed that the whistles will be blown a total of 15 minutes in any hour, accounting for about 450 whistle blows per hour. In other words, the whistles will not be blown continually for 15 minutes, but the total accumulated time of whistles being blown, assuming duration of whistle blow to be 2 seconds each, will be equivalent to 15 minutes. The time duration of cheering from the game spectators is assumed to be at least 45 minutes. This analysis assumes a maximum 5 hours of field activities per day.

Noise Source	Reference Level (Sound Power)	Comment
Whistles	106 dBA	Based on sound pressure levels measured at LT-2 from Ralston Middle School athletic field, 50' nominal distance
Cheering crowds	95 dBA	

Amphitheater: Noise from un-amplified voice and music on stage and audience applause and cheering during school assemblies and evening performances. School assemblies are assumed to take place once a week, while evening performances would occur at least once a semester during the school year. For a typical music or theatrical performance it is assumed that the audience would be cheering or applauding for no more than 15 minutes of any hour during the event. It is assumed that the sources on the stage will always be focused towards the audience, thereby eliminating direct sound to the residences across the canyon from the Proposed Project. Reflections off of the stage, audience seating area and the Proposed Project buildings are all incorporated into the SoundPlan model predictions. This analysis assumes a maximum 4 hours activities per day.

Noise Source	Reference Level (Sound Power)	Comment
Loud Voice (unamplified)	75 dBA	
Music	100 dBA	At fortissimo (loudest) levels
Applause	94 dBA	
Cheering Audience	95 dBA	

Construction Noise

Proposed Project construction activities would generally involve stationary equipment or slowly moving vehicles, and noise levels from these types of sources would attenuate 6 dBA for each doubling of distance. Reference noise levels for construction equipment at 50 feet are listed below.

Table 4-1 lists the typical construction equipment proposed for use under the Proposed Project, as described above in the project description. The table provides additional information regarding the approximate percentage of operational use during a typical daytime hour and the typical equivalent noise level (Leq) at 50 feet based on the Federal Highway Administration (FHWA, 2006). The data in Table 4-1 show the equivalent noise level under typical operation conditions.

Table 4-1 Noise Levels and Assumed Operational Parameters for Construction Equipment

Construction Equipment	Approximate Usage per Hour	Noise Level (dBA) at 50 feet		Phase
		Lmax	Leq (one hour)	
Backhoe	40%	78		Foundation
Backup Alarms**	1-5%	85 – 115 55 – 75 Class D	59 – 89 <50 Class D	Throughout
Bulldozer	40%	82		Demolition
Compressors and Generators*	40%	70 – 85 60 "quiet"	66 – 81 56 "quiet"	Foundation (2), Erection (2)
Concrete Mixer Truck	40%	79	75	Foundation
Crane	16%	81	73	Erection
Dump/Haul Truck	40%	77	73	Utilities (2)
Excavator	40%	81	77	Demo, Utilities
Forklifts and similar	40%	79	75	Erection
Grader	40%	85	81	Site Prep
Hoe Ram attachment	10%	90	80	Demo
Loader	40%	79	75	Demo (2), Utilities
Scraper	40%	84	80	Demo
Vibratory Roller Compactor	20%	83	76	Utilities
Water truck/Street sweeper	40%	75	71	Demo, Site Prep

Source: FHWA, 2006
* Quiet generators such as the MQ "Whisperwatt" series can generate 60 dBA or less at 50 feet. Electric powered compressors are quieter than diesel compressors.
** SAE J994, Class D ambient-adjusting alarms

Table 4-2 Summary of Construction Noise Effects

Receptor	Approximate Distance (ft)	Phase									
		Demolition		Foundations		Erection		Utilities		Site Prep	
		Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax	Leq	Lmax
Ralston School field	260	**72**	**76**	64	65	64	67	68	69	67	**71**
Ralston School	460	67	**71**	59	60	59	62	63	64	62	66
Lutheran Day School	490	66	70	58	59	58	61	62	63	62	65
Residences (North) – Belmont Canyon	515	61	65	53	54	53	56	57	58	56	60
Residences (East) - Arroyo View	690	63	67	55	56	55	58	59	60	59	62
Residences (South) – Wakefield Drive	890	61	65	53	54	53	56	57	58	57	60
Residences (West) – Tahoe Drive	910	61	65	53	54	53	56	57	58	56	60

Bold entries indicate noise levels could exceed 70 dBA for hourly Leq or individual Lmax events

4.2 NOISE IMPACT DISCUSSION

This discussion is broken up into two parts. The first section discusses the potential noise effects compared to the local noise ordinances, and the second section discusses the potential substantial noise increases based on speech or sleep interference effects. Both discussions address noise effects assuming no noise control techniques are incorporated into the Proposed Project.

Local Jurisdiction Requirements

Planning Guidelines – Land Use Compatibility

As noted above, the existing conditions at the CSUS School site (measurement locations 2 and 4), range from 48 to 53 Ldn. This existing environment is compatible with a school use, per the Belmont Noise Element, and thus no special measures are required to mitigate the noise environment (e.g., Ralston Avenue).

Construction noise

The expected noise at adjacent noise sensitive properties from demolition and construction activities is shown in Table 4-2. The construction noise estimates were made at two locations on the Ralston School property, and a representative receptor on each of the north, east west, and south sides were modeled. The City of Belmont has no specific noise limits for overall construction noise. As long as the hours of construction are restricted 8 AM to 5 PM Monday through Friday (excluding holidays) and 10 AM through 5 PM on Saturdays, with no work allowed on Sundays and holidays, there would be no impacts based on the local criteria.

Operational noise

The expected noise from the Proposed Project's outdoor activities was modeled at surrounding residential and sensitive properties is shown in Table 4-3. The receptor locations are shown in Figure 4-1. Per our analysis the Proposed Project would not exceed hourly Leq noise levels of 57 dB at the surrounding receptors. However, Lmax noise levels would exceed 55 dB at the school and residential properties to the north of the project, when a swim meet is held. Thus, if any pool activities would occur after 9 PM on weekdays, or 7 PM on weekends or holidays, noise control methods would be required to mitigate the noise impact. Table 4-3 also indicates the total contribution the Proposed Project would add to the existing ambient. Since in all cases the Ldn generated by the Proposed Project would be well below the existing ambient, the noise increase caused by the Proposed Project would be well below 0.01 decibel and not significant.

With the exception of pool-area activities, no noise control measures would be required for daytime operations. Noise control techniques are discussed further below.

Speech and Sleep Interference Effects

Construction Noise

As shown in Table 4-2 the noise from demolition and construction could exceed 70 dBA Leq at the adjacent Ralston Middle School during some phases of the work. In particular, demolition and construction activities could exceed 70 dBA at the nearest school building and at the outdoor field at Ralston Middle School.

Operational Noise

As shown in Table 4-3, the noise from all programmed outdoor activities would be below 70 dBA Leq at the surrounding residential and sensitive receptors (modeled receptors shown in Figure 4-1), and no speech interference effects would be generated. As all outdoor activities for the Proposed Project are programmed to occur during the daylight hours there would also be no contribution to sleep interference due to the Proposed Project.

4.3 ADDITIONAL COMMENTS

Conformance to the local noise ordinance and the significance thresholds notwithstanding, people can be annoyed by sounds that are audible and unwanted. To that end, this section addresses potential audibility issues for operational noise.

Humans are capable of hearing sounds that are less than the ambient level, if those sounds contain information or music content; our internal signal processing systems are capable of detecting useful information out of the "noise". As documented in the noise survey, typical daytime noise levels are 43 dBA Leq and higher at all locations, including Location LT-1. The noise model includes reflection effects off of buildings. Even so, the ground covering on the surrounding topography is acoustically "soft", absorbing much of the sound energy. The predicted noise levels from activities for the sports field of the Proposed Project would be less than the existing environment. Nevertheless, the sound levels would still be less than 33 dBA Leq on an hourly basis and less than 49 dBA on an Lmax basis, in both cases well below the existing noise environment. In particular, the neighbors along Ralston Avenue are already exposed to high noise levels from Ralston Avenue, further reducing the detectability of these sounds, and these sounds are already part of the existing noise environment as generate by Ralston Middle School.

Of all of the noise generated by the Proposed Project, swim meets at the pool area would generate the highest noise levels. Even so, the Leq noise levels at most nearby residents would be well below the existing ambient. For receivers to the north near the Lutheran Day School and near Belmont Canyon Road, since area is already exposed to high noise levels from Ralston Avenue, it would be difficult to detect sounds from the pool area.

Table 4-3 Summary of Predicted Noise Levels at Receptors Surrounding the Proposed Project

Rec. No.	Address/ Description	Existing Environment Representative Loc. [L_{dn}]	Predicted Noise Levels with Music Performance at Amphitheater[1] -NOT INCLUDED IN PROJECT		Predicted Noise Levels with Game at Sports Field[2]		Predicted Noise Levels with Swim Meet[3]		Total Project L_{dn}[6]
			Hourly L_{eq}[4] (dBA)	L_{max}[4] (dBA)	Hourly L_{eq}[4] (dBA)	L_{max}[4] (dBA)	Hourly L_{eq}[4] (dBA)	L_{max}[4] (dBA)	
1	11 Bryce Ct. / residential backyard	LT-1 [48]			10	21	28	39	20
2	1112 Lassen Dr. / residential backyard	LT-1 [48]			12	23	34	46	26
3	2700 Comstock Cir. / residential backyard	LT-1 [48]			17	25	38	50	30
4	2840 Wakefield Dr. / residential backyard	LT-1[48]			32	44	28	39	26
5	10 Soho Cir. / residential backyard	LT-1 [48]			15	25	34	45	26
6	2600 Ralston Ave. / Lutheran Day School	LT-3 [72]			33	45	57	**68**	49
7	2621 Belmont Canyon Rd. / residential backyard	LT-3[5] [72]			37	49	45	**57**	38
8	North bank of Water Dog Lake	LT-4 [48]			17	28	24	35	17

[1] Music performances produced the loudest noise levels at the amphitheater per the SoundPlan model, therefore these are the noise levels presented as a worst case situation. Music performances include spectator applause noise in addition to the actual musical performance. (Amphitheater is no longer included in the Proejct)
[2] A game includes spectator noise as well as noise generated by the players.
[3] A swim meet includes spectator noise as well as noise from air horns.
[4] The hourly Leq evaluated is the maximum hourly Leq for the specific event time period. The Lmax is the maximum short-duration noise level expected,
[5] Modeled Rec. #7 is shielded from Ralston Avenue by the topography of the area; however, LT-3 is the most representative measurement location.
[6] The total Project contribution to the Ldn would be well below the existing conditions. Thus, the total increase would be well below 0.01 decibel
Bold entries would exceed threshold criteria for daytime or nighttime operations

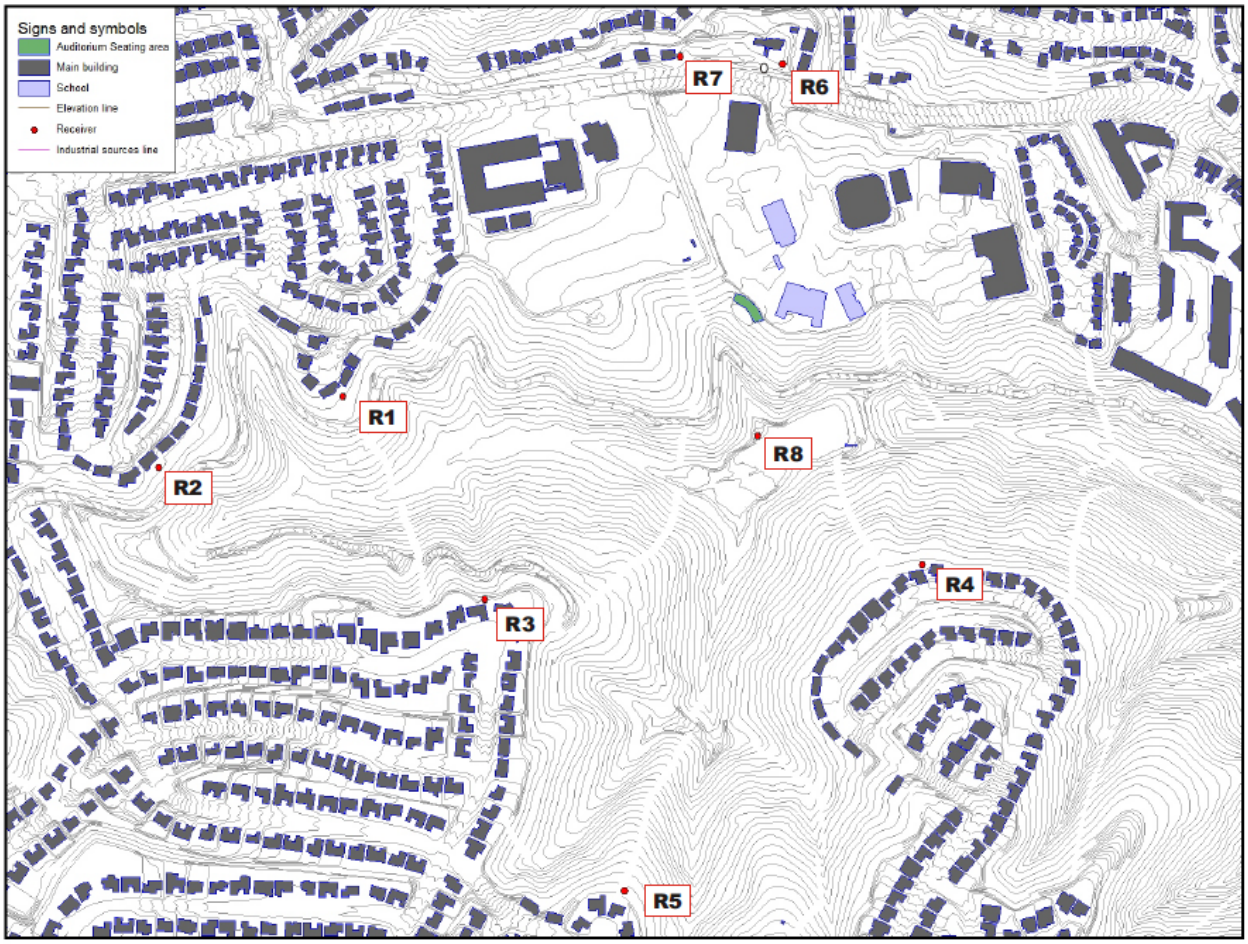

Figure 4-1 Receptor Locations as Modeled in **SoundPlan**

4.4 RECOMMENDED NOISE CONTROL TECHNIQUES

The following noise control techniques or their functional equivalent could be required for inclusion as mitigation to eliminate potential noise impacts:

Required Noise Control Techniques

Construction

- Temporary sound barrier, placed at the Ralston/CSUS property line as shown in Project Drawing A001. The sound barrier should be at least 8 to 10 feet high to block line of sight between noise-generating construction equipment and the Ralston Middle School activity areas and would provide about 10 dBA noise reduction at field area and about 5 dBA noise reduction at the Ralston Middle School buildings. Sound barriers and sound enclosures shall use materials with a minimum surface density of 3 pounds per square foot (e.g., plywood) to achieve a minimum Sound Transmission Class (STC) of 25. Multiple layers of a sound barrier curtain can be used to achieve a minimum total 2 lb/sq ft surface density (instead of 3 lb sq/ft). For rigid sound barriers and sound enclosures installed close to noise generating equipment, the inside face shall also be absorptive, with a minimum Noise Reduction Coefficient of 0.60 (e.g., 1 inch thick, 3 pound per cubic feet (pcf) duct liner). The sound barrier design shall be reviewed by a qualified acoustical consultant.

- Phased demolition. Where feasible, take advantage of the noise shielding effect provided by the existing structures to reduce demolition work noise (e.g., start from the east side), as noted in Drawing A001.

Operation

- The sound from the starter's device for swimming races would need to be reduced by 3 dBA. Following is a list of measures that could be used as noted on Project Drawing A001. Any one measure, or its functional equivalent, would provide the necessary noise control:

    1. Reduce the starter's device to a maximum 117 dB sound power level

    2. Ensure that the sounding device is directional, aimed only at the swimmers, and that the "off-axis" sound is at least 3 dB less than the "on-axis" sound.

    3. Use a distributed speaker system, with a speaker at each starting block, so that the total sound power provided does not exceed 117 dB (e.g., each speaker emitting no more than 107 dB sound power level at each speaker for an 8-lane pool).

    4. Configure the outdoor pool so that there is shielding for the school and receptors to the north of the project. The shielding could consist of a sound barrier fence, a building or similar structure to interrupt the line-of sight between the scoring position, where the starting gun or horn would sound for each heat, and the receptors to the north. Some examples to accomplish this include:

        - Low structure (sound fence, solid wall, solid bleachers, building, etc.) that blocks line of sight between the sounding device and the School, and

        - If there are several acoustically hard wall surfaces in the area surrounding the sounding device (i.e., concrete, stucco, etc.), apply acoustically absorptive finishes to eliminate sound build-up in this area. Appropriate products would include Pyrok Acoustement 40, Pyrok StarSilent panels or SoundBlox CMU.

Additional Techniques

As mentioned in Project Drawing A001, the following techniques and policies are not required for noise control of construction, but do represent best practices for construction site noise control and neighbor relations:

- Use best practices techniques to reduce noise from the site, including:

    - Site equipment at the work area to maximize the distance to noise sensitive receptors, and to take advantage of shielding provided by on-site equipment.

    - Operate the equipment mindful of the residential uses nearby, especially during the nighttime hours.

    - Maintain respectful and orderly conduct among workers, including worker conversation noise during the nighttime hours.

  - Maintain the equipment properly to minimize extraneous noise due to squeaking or rubbing machinery parts, damaged mufflers or misfiring engines, etc.

- Provide advance notice to nearby residents prior to starting work that is particularly noise, with information regarding anticipated schedule, hours of operation and a project contact person.

- Provide a minimum 24-hour advance notice to residents within 250 feet of the site prior to nighttime work involving drilling, drilling-related activities or truck deliveries.

- Site truck access routes away from noise-sensitive land use where possible.

- Layout the work sites to avoid reverse motions of large trucks, or sounding of any reverse motion alarms as much as possible. If this is not possible, trucks operating close to noise sensitive land uses should be outfitted with SAE J994 Class D alarms (ambient-adjusting, or “smart alarms”).

- Use “quiet” generators (e.g. MQ Whisperwatt or equivalent, rated no greater than 60 dBA at 50 feet or 67 dBA at 23 feet).

- Use a sound enclosure (e.g., three sides with a partial top) to shield stationary noise sources (portable generator, pumps, compressors, etc.) to reduce job site noise effects from noise sensitive receptors. The enclosure should be placed to provide sufficient ventilation while providing effective noise control. Nominally spacing the enclosure 3 to 5 feet from the noise source should be sufficient. Such an enclosure should provide approximately 10 to 15 dBA noise reduction of the equipment noise. To maximize the benefit of this enclosure, use NRC 0.9 absorptive material and barrier material with 5 to 8 pounds per square foot to achieve STC 40 (e.g., multiple layers of plywood, separated by 3” air gap).

5 REFERENCES

Federal Highway Administration (FHWA), *Roadway Construction Noise Model User's Guide*, January 2006.

United States Environmental Protection Agency, *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an adequate Margin of Safety*, March 1974.

6 APPENDIX A: NOISE BASICS

This section discusses the parameters, terms, and indices used to describe noise effects.

Basic Definitions

A glossary of common acoustical terms is included in Appendix A. Terms that are used extensively in this report are described and discussed below.

The sound level in decibels (**dB**) is used for noise impact analysis. The decibel scale is a logarithmic scale of the sound pressure amplitude relative to a reference sound pressure. In mathematical terms, the sound level is equal to 20 times the logarithm of the ratio of the time-varying sound pressure to a reference pressure of 20 *micro*-Pascals.

The root-mean-square[5] (**RMS**) amplitude of a sound or vibration is the square root of the time average of the square of the instantaneous amplitude over a specified time interval, usually one second ("slow" weighting). The RMS amplitude is described as an "energy average"[6] of the time-varying amplitude. The RMS sound level, or noise level, is the level in decibels of the RMS sound pressure divided by the reference pressure of 20 *micro*-Pascals. Unless otherwise stated, the RMS noise levels in this report are for a one-second RMS averaging time, or a "slow" meter response as used with a precision sound level meter.

The A-weighted sound level (**dBA)** is used for environmental noise analysis. The A-weighted sound level is obtained by weighting the frequency response of the measurement instrumentation or prediction formulas to closely represent the frequency response of the human ear to low-level sound. The A-weighted sound level correlates with human response to sound, has received universal acceptance both nationally and internationally, and is used extensively to describe noise impacts. All noise measurement results in this report are presented as A-weighted sound levels in dBA unless otherwise noted.

Vibration propagated through soil and building structures is referred to as **Groundborne Vibration**. In this analysis vibration is discussed in terms of the speed (velocity) at which the ground would move in units of inches per second.

Noise caused by vibration propagated through soil and building structures is **Groundborne Noise**. It is normally radiated by the ground in open air and by walls, floors, and ceilings inside a building as a result of groundborne vibration.

Sound is measured over varying periods of time; the terms described below measure noise (or vibration) over a given period of time.

The Equivalent Level (**Leq**) is the level of constant noise energy that is equivalent to the time-varying sound energy over a specified time period (e.g., over 15 minutes, an hour, or several

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[5] Mathematically, the RMS amplitude is the square root of the average of the squared amplitudes over a specified time interval.

[6] To distinguish this from an arithmetic average (e.g., the arithmetic average of 40, 50, and 60 is 50). The energy average of 40, 50, and 60 dB is 55.6, which favors the higher noise levels.

hours). Thus, the 24-Hour Leq refers to the energy equivalent level of sound for each 24-hour period. The Leq is equivalent to the RMS sound level, but determined over long periods of time.

The Community Noise Equivalent Level (**CNEL**) is used to describe the potential noise impact of a project on residential neighborhoods where sleeping is a principal activity at night. The CNEL is similar to the 24-Hour Leq, except that 5 dB is added to noise levels occurring between 7 PM and 10 PM and 10 dB is added to the noise levels occurring between 10 PM and 7 AM to account for the higher potential for disturbance to human activities in the evening and nighttime, respectively. In effect, a noisy event occurring during the night period has the same effect as 10 identical events occurring during the day. Thus, the CNEL is highly sensitive to late-night noise events.

The Day-Night Level (**Ldn or DNL**) is similar to the CNEL, but without the evening noise correction. The Ldn and CNEL are generally within 1 dBA of each other for most noise environments. As discussed below, the noise measurements indicate that the Ldn is typically 0.2 to 0.5 dBA less than the CNEL.

Typical Sound Levels

Examples of typical environmental noise levels are presented in Figure A-6-1. The typical background sound level in a quiet urban environment is about 40 to 50 dBA. The lower end of the range occurs at night and the upper end during the day, depending on the number and proximity of noise sources. Superimposed against the background sound level is noise from aircraft, nearby automobiles, neighborhood activities, house construction, etc. For example, an automobile passing a home in a residential neighborhood at low speed produces noise at a level of about 75 dBA at 50 feet from the source. A common motorcycle produces noise at a level of about 90 dBA at 25 feet. A gasoline-powered lawn mower produces noise at a level of about 75 dBA at 50 feet. Birds (in distant trees) produce sound at levels of about 45 dBA. Modern air conditioning units produce exterior noise at levels of about 55 dBA at 15 feet. The ambient sound level is comprised of the background and the intermittent, every day sounds.

Airborne noise attenuates as a function of the distance from point sources at a nominal rate of 6 decibels for each doubling of distance[7] between source and receiver without consideration of attenuation due to barriers or ground effects.

The intervening ground cover and topography can substantially attenuate noise. For propagation of sound over grassy or cultivated surfaces where the propagation path is within 10 feet of the surface, an additional attenuation of about 1.5 dB per doubling of distance is often used for prediction. Intervening hills substantially reduce noise, often by 20 or more decibels. Buildings and other hard barriers can provide between 5 and 15 dB of noise reduction. The measured ambient noise level data presented in this report are inclusive of the existing topography, structures, and barriers.

[7] This is known as the "inverse square law," where the sound intensity is inversely proportional to the square of the distance from the source, and the sound pressure is inversely proportional to the distance from the source.

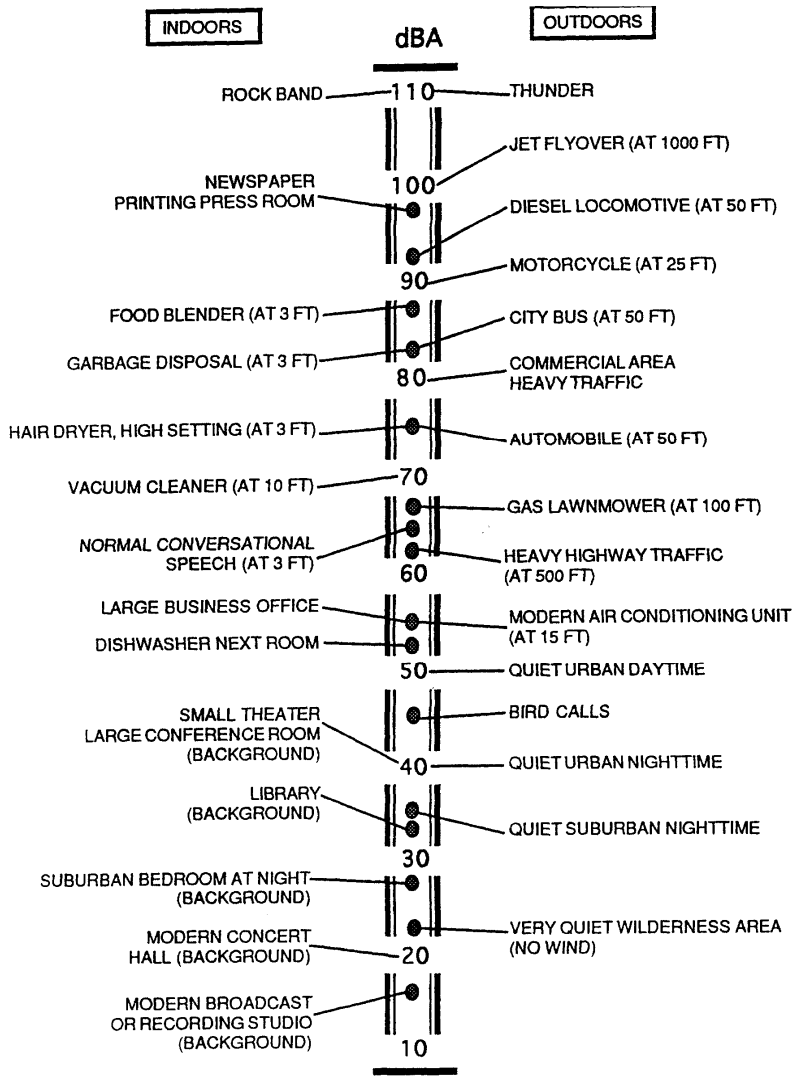

Figure A-6-1 Typical Environmental Sound and Noise Levels

Health Effects and Annoyance

Noise at high levels (i.e., over 120 dBA for one-time events or over 80 dBA for long-term exposure) as measured at the ear can be damaging to the ears of people and result in permanent or temporary loss of hearing as well as severe emotional distress. For this project, noise at close range (i.e., 15 feet) to the source would only be a hazard for construction workers, who would potentially experience the noise as much as 8 hours per day. The hazards of high noise levels to workers are addressed through requirements established by the California Department of Industrial Relations, Division of Occupational Safety and Health and are not addressed in this report. Thus, for the project noise impact assessment, the focus is on the effects that the project-generated noise would have on adjacent noise-sensitive land uses, including residential, schools, office, and commercial land uses. The predicted noise levels indicate that construction noise at residences or commercial structures would not be sufficient to cause hearing damage.

Noise is inherently based on the concept of disturbance and annoyance to the receptor that hears the sound, and thus the response of individuals is subjective. Annoyance and disturbance as a response to noise is often affected by several factors, including:

- Character:
  - Does it contain tones, screeches, music, or speech?
  - Is the noise constant, repetitive, or irregular?
- Difference in character from ambient sound level
- Identifiability, familiarity
- Lack of control (timing, occurrence, startle factor)
- Change in sound level
- Absolute sound level

The temporary change from a quiet urban sound environment (which includes various sources of noise) to one that is strongly influenced by construction noise can annoy people, regardless of the absolute noise level.

In general, increasing the level of steady, continuous noise by 3 dBA may be noticeable to most people with good hearing, assuming that the noise maintains the same character. An increase of 5 dBA is generally noticeable, and an increase of 8 to 10 dBA is often perceived as a doubling of the noise. However, changing the character of the noise is very perceptible, even if no increase in noise level occurs. For instance, the human ear may perceive the introduction of a tonal noise, even at 5 to 10 dBA below the existing ambient. Tonal noise slightly *less than* the ambient could cause annoyance to some people.

Other than the effect of annoyance and the effect that annoyance has on psychological and related physical health, noise can also cause sleep disturbance, either by waking people from sleep or by making return to sleep difficult. Maximum noise levels (e.g., caused by a single event or series of events) on the order of 50 to 55 dBA inside a home can wake people from sleep, although a single event up to 75 dBA can be experienced with no substantial awakening. The noise insulation provided by many homes in California is about 15 dBA with windows open. Newer construction homes with double-paned windows can easily achieve noise insulation of 25 dBA or greater with windows closed.

Buildings serve as low-pass sound filters. The exterior noise that passes through the building shell to the interior tends to lose its higher frequencies, while the low frequencies are less attenuated. People are generally less sensitive to low-frequency noise than mid-frequency noise; however, if the low-frequency noise level is comparable or higher than the ambient noise environment, it can cause discomfort and sleep disturbance. For this reason, low-frequency noise from equipment such as large fans or diesel engines may cause complaints, even if the A-weighted sound level is below the ambient.

7 APPENDIX B: GLOSSARY OF ACOUSTICAL TERMS RELEVANT TO ENVIRONMENTAL PROJECTS

Accelerometer: A vibration-sensitive transducer that responds to the vibration acceleration of a surface to which it is attached. The electronic signal generated by an accelerometer is directly proportional to the surface acceleration.

Acceleration Level: Also referred to as "vibration acceleration level." The acceleration level is 20 times the logarithm to the base 10 of the ratio of the acceleration to a reference acceleration. The commonly accepted reference acceleration is 10-6 g (10-5 m/sec).

Acceleration: The rate of change of velocity with respect to time.

A-Weighted Sound Level (dBA): The sound pressure level in decibels as measured on a sound level meter using the internationally standardized A-weighting filter or as computed from sound spectral data to which A-weighting adjustments have been made. A-weighting de-emphasizes the low and very high frequency components of the sound in a manner similar to the response of the average human ear. A-weighted sound levels correlate well with subjective reactions of people to noise and are universally used for community noise evaluations.

Airborne Sound: Sound that travels through the air, as opposed to structure-borne sound.

Ambient Sound (Noise) or Vibration: The prevailing general sound and noise or vibration existing at a location or in a space, which usually consists of a composite of sounds or vibration sources from many sources near and far.

Background Sound (Noise) or Vibration: The general composite non-recognizable sound and noise or vibration from all distant sources, not including nearby sources or the source of interest. Generally, background noise or vibration consists of a large number of distant noise or vibration sources and can be characterized by L90 or L99.

Community Noise Equivalent Level (CNEL): The Leq of the A-weighted noise level over a 24-hour period with a 5-dB penalty applied to sound levels between 7 PM and 10 PM and a 10-dB penalty applied to sound levels between 10 PM and 7 AM.

Crest Factor: The ratio of the peak amplitude to the root-mean-square (RMS) amplitude. The crest factor can be assumed to be 4 for random vibration.

Day-Night Equivalent Level (Ldn): The Leq of the A-weighted sound level over a 24-hour period with a 10-dB penalty applied to sound levels between 10 PM and 7 AM.

Decibel (dB): The decibel is a measure on a logarithmic scale of the magnitude of a particular quantity (such as sound pressure, sound power, and sound intensity) with respect to a standardized quantity.

Displacement: The distance a particle moves as a result of vibration.

Energy Equivalent Level (Leq): The level of a steady sound that would have the same energy as the fluctuating noise level integrated over the time period of interest. Leq is widely used as a single-number descriptor of environmental noise. Leq is based on the logarithmic or energy

summation, and places more emphasis on high sound level periods than does L50 or a straight arithmetic average of noise level over time. This energy average is not the same as the average sound pressure levels over the period of interest, but must be computed by a procedure involving summation or mathematical integration.

Frequency (Hz): The number of oscillations per second of a periodic noise (or vibration) expressed in Hertz (abbreviated Hz). Frequency in Hertz is the same as cycles per second.

Groundborne Noise: Noise caused by vibration propagated through soil and building structures. It is normally radiated by the ground in open air and by walls, floors, and ceilings inside a building as a result of vibration which, after being produced by a source some distance away, travels through the soil in the form of elastic waves.

Groundborne Vibration: Vibration propagated through soil and building structures. The vibration travels through the soil in the form of elastic waves.

Octave Band - 1/3 Octave Band: One octave is an interval between two sound frequencies that have a ratio of two. For example, the frequency range of 200 Hz to 400 Hz is one octave, as is the frequency range of 2,000 Hz to 4,000 Hz. An octave band is a frequency range that is one octave wide. A standard series of octaves is used in acoustics, and they are specified by their center frequencies. In acoustics, to increase resolution, the frequency content of a sound or vibration is often analyzed in terms of 1/3-octave bands, where each octave is divided into three 1/3-octave bands.

Pascal: One Newton per square meter.

Peak Acceleration: The maximum excursion of instantaneous vibration acceleration amplitude from zero.

Peak Displacement: The maximum excursion of instantaneous vibration displacement amplitude from zero.

Peak Particle Displacement: See Peak Displacement.

Peak Particle Velocity: See Peak Velocity.

Peak Velocity: The maximum excursion of instantaneous vibration velocity amplitude from zero.

Root Mean Square (RMS): The square root of the average over a period of time of the square of the amplitude.

Root Mean Square Velocity: The square root of the average over a period of time of the square of the velocity amplitude.

Sound Pressure Level (SPL): The sound pressure level of sound in decibels is 20 times the logarithm to the base of 10 of the ratio of the RMS value of the sound pressure to the RMS value of a reference sound pressure. The standard reference sound pressure is 20 *micro*-Pascals, as indicated in ANSI S1.8-1969, “Preferred Reference Quantities for Acoustical Levels.”

Statistical Distribution Descriptors (L1, L10, L50, L90, etc): Also called Exceedance Levels, they represent the level of the sound (A-weighted for environmental studies) or vibration that is exceeded a percentage of the duration of the measurement period, as denoted by the subscript. So, for instance, L10 is the level of the sound or vibration exceeded for 10 percent of the measurement period (usually one hour in long-term environmental studies).

> **L99** and **L90** are descriptors of the typical minimum or "residual" background sound (or vibration) levels observed during a measurement period, normally made up of the summation of a large number of sound sources distant from the measurement position and not usually recognizable as individual noise sources. Generally, the prevalent source of this residual sound is distant street traffic noise. L90 and L99 are not strongly influenced by occasional local motor vehicle passbys. However, they can be influenced by stationary sources such as air conditioning equipment.
>
> **L50** represents a long-term statistical median sound level over the measurement period and does reveal the long-term influence of local traffic noise.
>
> **L10** describes typical levels or average for the maximum sound levels occurring, for example, during nearby passbys of trains, trucks, buses and automobiles, when there is relatively steady traffic noise. Thus, while L10 does not necessarily describe the typical maximum noise levels observed at a point, it is strongly influenced by the momentary maximum noise level occurring during vehicle passbys at most locations.
>
> **L1**, the sound level exceeded for 1 percent of the time, is representative of the occasional, isolated maximum or peak level that occurs in an area. L1 is usually strongly influenced by the maximum short-duration noise level events that occur during the measurement time period and are often determined by aircraft or large vehicle passbys.

Structure-Borne Sound: Generated by vibration traveling through the structure and causing the floors, ceiling and/or walls to vibration and re-radiate sound.

Velocity: The rate of change of displacement with respect to time.

Velocity Level: Also referred to as the "vibration velocity level." The velocity level is 20 times the logarithm to the base 10 of the ratio of the RMS value of the velocity to a reference velocity. In this report the reported vibration velocity levels are all referenced to 10^{-6} in/sec.

Vibration: In this context, the motion of an object (e.g., the ground) in response to random or harmonic excitation. Vibration can be measured in terms of acceleration, velocity or displacement.

WILSON IHRIG & ASSOCIATES
ACOUSTICAL AND VIBRATION CONSULTANTS

CALIFORNIA NEW YORK WASHINGTON

6001 SHELLMOUND STREET
SUITE 400
EMERYVILLE, CA 94608
Tel: 510-658-6719
Fax: 510-652-4441
www.wiai.com

17 August 2012

Ms. Jennifer Renk
McKenna Long & Aldridge LLP
Rincon Center II
121 Spear Street, Suite 200
San Francisco, California 94105-1582

Subject: CSUS Belmont, Acoustical Analysis Updates

Dear Ms. Renk:

This letter provides information related to outdoor sounds associated with CSUS' revised project drawings for the City Council meeting on September 11, 2012, which now completely enclose the pool.

The corrected copy of our acoustical analysis report was prepared on 2 July 2012. Shortly afterwards , on 10 July 2012 Jason Mirise with ESA provided a peer review comment letter, in which he concurred with the calculations provided in our 2 July 2012 report and concluded that the "project-related noise exposure is not expected to exceed the applicable noise exposure limits." Since that time, a key change to the proposed Project includes fully enclosing pool to control noise from pool activities (e.g., whistles, starter horns and crowd noise).

We have assumed that the full-enclosure building would be constructed of materials similar to the gymnasium building (walls are 10" pre-cast concrete with interior framing, rigid insulation and backer board and tile; roof is a membrane over rigid insulation over metal deck; windows are dual-glazed windows with ¼" thick glazing and ½" air gap), and full enclosure of the pool would typically reduce these kinds of sounds by about 25 to 30 dBA or more. Thus, sounds from pool activities would be less than the existing noise environment:

- Homes to the north of the Project (north of Ralston Avenue) would experience sounds from pool activities less than 45 dBA; existing typical daytime maximum noise levels exceed 70 dBA,
- Homes to the west of the Project would experience sounds from pool activities less than 15 dBA; existing typical daytime maximum noise levels exceed 45 dBA,
- Homes on the south side of the canyon would experience sound from pool activities 25 dBA and less, where the existing typical daytime maximum noise levels are expected to be about 46 dBA.

As with the previous pool configuration, these sound levels would comply with the applicable Belmont noise criteria, but now any sounds associated with pool activities would be less perceptible to the surrounding residents, a source of great concern to these neighbors.

No changes are currently proposed for the outdoor sports field. As indicated in our 2 July 2012 acoustical report, at all residential areas surrounding the Project, the sound level from whistles and cheering crowds would comply with the applicable Belmont noise criteria and be comparable to or well below the existing noise environments:

- Homes to the north of the Project (north of Ralston Avenue) would experience sounds from the sports field less than 50 dBA; existing typical daytime maximum noise levels exceed 70 dBA,
- Homes to the west of the Project would experience sounds from the sports field less than 25 dBA; existing typical daytime maximum noise levels exceed 45 dBA,
- Homes on the south side of the canyon would experience sound from the sports field less than 45 dBA, where the existing typical daytime maximum noise levels are expected to be about 46 dBA.

CSUS remains committed to requiring the use of low-decibel, higher frequency whistles that have been designed for facilities in close proximity to residential uses, so the sound levels arising from the field use will not only comply with the City's noise criteria, but the sounds will be less perceptible to the neighbors than has been feared.

Very truly yours,

WILSON, IHRIG & ASSOCIATES, INC.

Deborah A. Jue
Principal

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WILSON IHRIG & ASSOCIATES
ACOUSTICAL AND VIBRATION CONSULTANTS
CALIFORNIA NEW YORK WASHINGTON

6001 SHELLMOUND STREET
SUITE 400
EMERYVILLE, CA 94608
Tel: 510-658-6719
Fax: 510-652-4441
www.wiai.com

14 September 2012

Ms. Jennifer Renk
McKenna Long & Aldridge LLP
Rincon Center II
121 Spear Street, Suite 200
San Francisco, California 94105-1582

Subject: CSUS Belmont, Response to Comments at City Council Meeting
Mr. Moody, 11 September, 2012

Dear Ms. Renk:

This letter provides a response to some of the comments made by Mr. Moody at the 11 September, 2012 City Council Meeting. The transcript we received of his comments is attached for your reference.

At the request of the City of Belmont, we are responding to the comment made by Mr. Moody:

> Many people believe the sound traveling from this project will be similar to Ralston School. It is important to note that Ralston field is at a higher elevation, further away, and buffered by a mature tree line to the south rim homes. The project field is different as it is closer positioned with an unobstructed line of sight to those homes.
>
> The Noise Study predicts that *"The sound level from whistles and cheering crowds would be comparable to or well below the existing noise environments:"*
>
> Numerous errors have been identified by the public; described by the study's author as substantial and professionally embarrassing. I continue to expect the actual field noise will be above predictions and the existing noise environment.

Following is a point by point response:

- *Ralston field is at a higher elevation (than the CSUS field):*
  - Yes, this is true. Based on topography provided to us, the elevation of the CSUS field at the southwest corner would be about 154 m (505 ft). The elevation of the RMS field is about 163 m (535 ft) at the ball diamond home plate (southeast corner), and the elevation is about 164 m (538 ft) along the southern edge of the west soccer pitch. The elevation difference is almost 10 m (33 ft).

- *Ralston field is further away (than the CSUS field):*
    - This is generally true for homes on Wakefield Dr., but this is not true for all homes along the south canyon rim. The horizontal distance from the southwest corner of the CSUS field to the modeled south canyon home on Wakefield (Receptor 4) is about 399 m (1309 ft). The corresponding distance to the RMS southeast home plate is about 430 m (1411 ft) and 517 m (1696 ft) to the RMS west soccer pitch.
    - Based on these differences in distance, a noise source generated on the RMS fields and received at a residence near Receptor 4 would be less than the same source generated on the CSUS field – 0.6 dBA different for sounds at the RMS southeast home plate and about 2.2 dBA different for sounds at the RMS west soccer pitch.

- *Ralston field is buffered by a mature tree line to the south rim homes (the CSUS field would not have many mature tree to shield it).*
    - Yes, there is a single row of trees along the perimeter of the RMS property which provides a visual screen.
    - However, the ability of trees or other landscaping to provide a barrier to reduce noise is a widely misunderstood concept. In order to provide a meaningful noise reduction, the trees need to be densely packed with a depth of typically 50 to 100 ft. The effect these dense woods provide is to increase the ground absorption and to reduce some of the sound transmitted through the air. The single row of trees surrounding RMS is not sufficient to provide any meaningful amount of noise reduction on an A-weighted basis. Trees definitely provide a visual barrier which can provide benefits for an "out of sight => out of mind" effect.

- *The project field is different as it is closer positioned (than the RMS field) with an unobstructed line of sight to those homes.*
    - This is generally true for homes on Wakefield Dr., but this is not true for all homes along the south canyon rim.
    - Based on the differences in distance and elevation discussed above, as received at Receptor 4 on the south canyon, a noise source generated on the RMS fields close to the southeast ball field would be about 2 dBA less than the same noise source generated on the CSUS field; a noise generated at the west soccer pitch would be be about 5 dBA less than the same noise generated on the CSUS field. As noted above, the difference in tree screening would not affect the noise levels.

- *The Noise Study predicts that "The sound level from whistles and cheering crowds would be comparable to or well below the existing noise environments:"*
  Numerous errors have been identified by the public; described by the study's author as substantial and professionally embarrassing. I continue to expect the actual field noise will be above predictions and the existing noise environment.
    - Mr. Moody appears to be asserting that based on his qualitative assessment based on the proximity of the CSUS field to the RMS fields, he expects that this statement from the Noise Study is inaccurate.
    - The Noise Study is based on quantitative comparisons in the Noise Study which compare the modeled sound levels from the CSUS field to the measured (and expected) existing conditions, and does not assume that the CSUS field would be

similar based on proximity of the project to RMS and the surrounding neighborhood.

- The modeled results from the CSUS field indicates that the maximum noise level would be 44 dBA, which would be less than the existing hourly maximum level of 60 dBA or more at the south canyon, and less than the existing typical maximum level of 46 dBA or more at the south canyon.
- The modeled result for Receptor 4 includes only a very small correction for the topography, and thus it is easy to double check the result using simple geometry. The results at other receptors incorporate varying amounts of excess attenuation from topography and building orientation, and are within reason as indicated in the peer review from ESA.
- Note that the Noise Study employed a whistle sound power of 106 dBA, consistent with measured results at the RMS field and typical usage during sporting events. CSUS has committed to using a whistle with a lower sound level, potentially with a sound power of 100 dBA or lower. Thus the maximum sound levels would be even further reduced by 6 dBA or more.

Further, there has been some concern previously expressed by Mr. Moody at Planning Commission meetings that the sound environment at the south canyon was not properly characterized in the Noise Study. Mr. Moody has expressed doubt that the existing conditions measured at the north canyon (Hiking trail, LT-1) are as quiet as the environment at the south canyon, citing the different proximities of the two areas to Ralston Avenue. In the Noise Study, the south canyon existing conditions were characterized from the noise measurements at LT-1 based on the following:

- The contribution of noise distant noise sources (airport, 101 and 280) is expected to be about the same for all receptors near the canyon.
- LT-1 is shielded from Ralston Avenue due to intervening buildings and topography, easily providing at least 15 dBA noise reduction compared to a receptor of comparable distance and clear line of sight to Ralston Avenue. Thus, we expect that the contribution of noise from Ralston Avenue is not substantial at LT-1; it was difficult to hear traffic on Ralston at this location. It is possible that noise from Ralston Avenue is more audible at the south canyon than at LT-1, based on the topography conditions.
- LT-1 is about 1,300 ft from the center of the RMS fields; homes along the south canyon are about 1,300 ft to 1,600 ft from the RMS fields. Based on this distance, the sounds experienced from RMS would be comparable between LT-1 and the south canyon.
- LT-1 is partially shielded from the RMS fields by the homes on Bryce Ct. and Tahoe Dr., thus any RMS noise measured at LT-1 was possibly less than the RMS noise experienced by homes along the south canyon.
- Thus, it is possible that the south canyon noise environment is slightly higher than that at LT-1; by assuming that the noise levels at the south canyon are comparable to those measured at LT-1, we believe that we have provided a reasonable level of conservatism in the analysis by assuming that the south canyon noise levels are the same as LT-1.

Very truly yours,

WILSON, IHRIG & ASSOCIATES, INC.

Deborah A. Jue
Principal

301348871.1

Operational Noise Comments –John Moody, September 11, 2012

Pool

I thank the city for the additional peer review which confirmed the large errors I pointed out in the pool noise estimates.

The city must ensure the pool enclosure performance[1] has a risk mitigation plan i.e., it performs as planned. The performance should be verified early so that underperforming results are mitigated before the project is finished. [Windows should be non-opening fixed glazing]

There is little detail on the method of heating the pool. That and the equipment room design should be captured in the risk mitigation plan. [Including ventilation e.g., acoustic louvers]

Field

Many people believe the sound traveling from this project will be similar to Ralston School. It is important to note that Ralston field is at a higher elevation, further away, and buffered by a mature tree line to the south rim homes. The project field is different as it is closer positioned with an unobstructed line of sight to those homes.

The Noise Study predicts that *"The sound level from whistles and cheering crowds would be comparable to or well below the existing noise environments:"*[2]

Numerous errors have been identified by the public; described by the study's author as substantial and professionally embarrassing. I continue to expect the actual field noise will be above predictions and the existing noise environment.

The planning commission has a requirement to evaluate new projects for the impact of increased noise on the community. Because the study predicts the condition will not exist, that evaluation was not performed.

I support the sports complex synthetic turf project. If that moves forward, even at the low estimate, the increase in field hours substantially exceeds that offered by Crystal to the City. Turf could eliminate the need for the city to regulate and police outside users of the Crystal field as the field could be restricted to Crystal activities.

If the field noise *does* increase the ambient noise environment, other than limiting use, there is no suitable mitigation available due to the direct sightline. A no-noise Sunday requirement is requested to avoid a 7 day-a-week impact.

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[1] Performance criterion is stated in letter to Ms. Renk from Wilson Ihrig & Assoc., 17 August 2012, pg 408 of meeting packet

[2] Ibid.