The Acoustics & Vibration Group
5700 Broadway Sacramento, CA 95820-1852
916-457-1444 FAX: 916-457-1475
Consultants in Acoustics, Vibration & Noise Control

NOISE IMPACT TO AND BY MULTI-USE DEVELOPMENT ON OLD PLACERVILLE ROAD AND RECOMMENDATIONS TO MEET CITY OF RANCHO CORDOVA NOISE LIMITS

Prepared for

Tower Development Corporation
4378 Auburn Boulevard, #300
Sacramento, CA 95841

Prepared by

KENT F. MCKELVIE, ENGINEER

Approved by

STEVE PETTYJOHN, PRINCIPAL
CERTIFIED: INSTITUTE OF NOISE CONTROL ENGINEERS-1981

May 8, 2006

R06140

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 SUMMARY

This report documents the noise impact of road traffic, truck deliveries, mechanical equipment and aircraft flyovers on the proposed multi-use development east of Bradshaw Road on Old Placerville Road in Rancho Cordova. The impact of activity at the proposed project on existing residential developments was evaluated also. Traffic on US 50 is the dominant sound source with non-transportation sources at the retail center to the west a significant contributor at proposed single-family home section of the development. Aircraft flights from Mather are an important sound source with some contribution from traffic on Old Placerville Road. Other sources include landscape service activity, dogs barking and general human activity. Traffic on US 50, truck deliveries and mechanical equipment are expected to remain the dominant sound sources up to the design year of 2026. Traffic on Old Placerville Road and aircraft flights out of Mather are expected to remain important sources impacting the residential part of the project. Landscape services and other general human activity at surrounding properties are expected to remain secondary sound sources.

Mechanical equipment and general activity at the project site could potentially impact existing and future residential development in the area. Traffic generated by the project could have a noise impact on existing and future residential areas also. Non-transportation sound sources at the project site are very difficult to quantify because information is not available. The developer must be made aware that sound generated by mechanical equipment and parking lot activity must meet the City of Rancho Cordova's Noise Control Ordinance [1]*. Traffic generated by this project is expected increase day-night average, L_{dn}, sound levels by less than 0.5 dB in the surrounding area.

This multi-use development will house both residential property and office buildings at the project site. The north portion of the project site will hold 27 detached single-family homes and 8 attached single-family homes. The south portion of the project site comprises four office buildings and an access road for the residences. North and east of the project site is residential property. A multi-family development is south of the site across Old Placerville Road. A commercial/retail center lies west of the project site. A large supermarket at this center is the closest facility to the site. The supermarket has two loading docks and a cooling tower on the east side of the building. An 8-foot high wood fence separates the supermarket from the project site.

The City of Rancho Cordova is currently completing their draft General Plan [2], but it has not been adopted. Since the City does not have a Noise Element, the Sacramento County Noise Element [3] was used to evaluate noise impacts. The City of Rancho Cordova has adopted a Noise Ordinance [1] that is based on Sacramento County's Noise Control Ordinance [4]. The County's Noise Element is a planning device that sets goals for both transportation and non-transportation sound sources. The impacts to and by the project must be evaluated. The City's Noise Control Ordinance applies to non-transportation equipment and transportation equipment while on private property. A backyard or activity L_{dn}, sound level goal of 60 dB is set by the County's Noise Element. An L_{dn} sound level of 65 dB is allowed where reaching the 60 dB is not feasible. For non-transportation sound sources, the Noise Element permits the sound level exceeded 50 percent of any hour, L_{50}, sound level of 50 dB during the day and 45 dB at night. The maximum, L_{MAX}, sound level limit is 70 dB during the daytime and 65 dB at night. A 5 dB penalty is applied sound comprising speech, music, pure tones or impacts.

---

* - *Number(s) in brackets refer to references listed at the end of this report.*

The City's Noise Control Ordinance has a range of limits based on the duration of the sound during any 1-hour period. The daytime limit for the L_{50} sound level is 55 dB while the nighttime limit is 50 dB. The daytime limit for the L_{MAX} sound level is 75 dB while the nighttime limit is 70 dB. The penalty requirements are the same as the County's Noise Element.

The existing L_{dn} sound levels in the residential area vary from 71 dB along Old Placerville Road to 63 dB near the supermarket at the northwest corner to 59 dB at the northeast corner. Future residential L_{dn} sound levels will not exceed 63 dB at the home at the southeast lot and 64 dB at the home closest to the supermarket loading dock and cooling towers. The predicted L_{dn} sound levels are all less than the upper limit given in the County's noise element. The L_{dn} sound level at the south face of the office buildings closed to Old Placerville Road is estimated to be 74 dB.

Existing sound levels due to non-transportation equipment and transportation sources while on private property vary significantly. These sources mainly influence lots proposed along the west side of the project site. High background sound levels made it difficult to measure the sound from the cooling towers at the supermarket. The sound level exceeded 50 percent of the time, L_{50} sound level, is estimated to be between 52 and 56 dB. Both values exceed the County's Performance Standard and the City's nighttime limit. The City's daytime limit for the L_{50} sound level is exceeded only by the upper range. Sound generated by dock activities varied significantly and was influenced by background sound levels. If background L_{50} sound levels fall below 50 dB, these activities will exceed the nighttime sound limits. An assumption was made that lower nighttime sound levels would be expected on hot summer days. As a result, the predicted sound levels exceed the City's Noise Control Ordinance. Sound levels from the cooling towers and loading dock operations are not expected to change for cumulative plus project conditions. Thus, existing sound levels will remain the same and nighttime sound limits would be exceeded when background sound levels are low. Building a 10-foot high sound wall along the west property line will reduce residential sound levels below the City's limits for all conditions. The impact will be insignificant with this mitigation measure.

An interior L_{dn} sound level limit of 45 dB is set by the County's Noise Element for both single and multi-family homes. The State of California [5] requires interior L_{dn} sound level to be 45 dB or less in habitable spaces of all multi-family homes. Attached single-family homes, e.g., duplexes, very high density housing with common walls or floor/ceiling assemblies or apartments and condominiums are classified as multi-family units by the State. Interior L_{dn} sound levels were predicted using information obtained from the site plan and architectural drawings [6]. A 43 dB(A) L_{dn} sound level design goal was used to furnish a safety factor of 2 dB. This accounts for errors in the models and the use of laboratory sound loss data that will not reflect field construction procedures and techniques. Interior L_{dn} sound level in all units will not exceed the design goal or the County or State's limits. Exterior wall construction must meet minimum construction requirements. Noise impacts will be less than significant when basic design requirements are met.

2.0 ACOUSTIC STANDARDS

This noise study was done following general requirements of the City of Rancho Cordova. Lacking an adopted General Plan, the Noise Element from the County of Sacramento [3] was employed to evaluate this project along with the City's Noise Control Ordinance. The understanding is that the City adopted the County's Noise Element requirements in the interim. The County's Noise Element addresses both transportation sound sources while the City's Noise Control Ordinance focuses

only on non-transportation sound sources or transportation sound sources while on private property. The sound descriptors used to set limits differ for these two types of sources. Interior limits are established for all residences in the County's Noise Element while the State sets interior limits for multi-family homes or attached single-family homes. The following sections describe these requirements.

2.1 County Exterior Limits, Transportation Sources

Transportation sound sources and some non-transportation sound sources that run continuously are evaluated based on the day-night average, L_{dn}, sound level. The day-night noise descriptor averages measured or predicted sound levels over 24-hours after applying a 10 dB penalty to nighttime sounds. Hourly average sound levels, L_{eq}, are measured or predicted for each hour of the day or for each hour during which a sound source is present. A 10 dB penalty is added to each hourly average sound level measured or predicted from 10:00 p.m. to 7:00 a.m. The penalty is applied because people trying to sleep during these hours are more sensitive to external sounds. Excluding or including only certain sources is possible. For example, the sounds of aircraft operating over a project site are included only during those hours when they occur. If there are no events during the nighttime, no penalty would be applied. When some sources are excluded from the analysis, the resulting sound level is called the Background L_{dn} sound level. An acoustical study is needed when the activity areas of noise-sensitive land uses will be subjected to day-night average sound levels, L_{dn}, greater than 60 dB. The goal is to achieve a backyard L_{dn} sound level of 60 dB in all single-family homes. An upper limit for the L_{dn} sound level of 65 is allowed when meeting the lower limit is not feasible. These goals would apply to the backyards of the residential land at the project site and the surrounding noise-sensitive sites.

2.2 County Interior Limits, Transportation Sources

The County's Noise Element sets limits for the maximum interior L_{dn} sound level in residential property. Interior limits are set for other spaces such as offices, but this project only evaluates interior levels at the residential property. Interior L_{dn} sound levels for dwellings are not to exceed 45 dB.

2.3 County Exterior Limit, Non-Transportation Sources

A second criterion in the County's Noise Element is given in the Performance Standards. The Performance Standard addresses the sound of new or existing non-transportation sources as they influence new or existing residential property. Limits are given based on the time of day, tonal content of the sound and type of sound. This section employs the sound level exceeded 50 percent of the time in any hour, the L_{50} sound level, and the maximum, L_{MAX}, sound level as the measures of the noise impact. Sounds that contain pure tones, speech, music or recurring impulsive sounds have an additional 5 dB penalty. A pure tone is what you hear when you blow across the mouth of a soda pop bottle half filled with a liquid. An example of impulsive sound is that generated when a car door suddenly closes. The Performance Standard provides no system to deal with conditions where background sound levels are greater than the limits. A noise study is required if predicted noise from a project or on a project will exceed the limits given in the Performance Standard. Performance Standard limits presented in Table I apply at the closest property line.

TABLE I. Performance Standard Noise Limits from the County of Sacramento Noise Element for Residential Property Affected by Non-Transportation Sources.

Statistical Noise Level Descriptor	Exterior Sound Level Limits, dB(A)	
	Daytime 7 a.m. to 10 p.m.	Nighttime 10 p.m. to 7 a.m.
L_{50}	50	45
L_{MAX}	70	65
Penalty for tones, speech, music, impulses	-5	-5

- Add to limit when sound comprises these.

2.4 City's Noise Control Ordinance

The City of Rancho Cordova's Noise Control Ordinance [1] is very similar to the Performance Standard, though it is not as restrictive. This Ordinance is a City code and is enforceable with limited exceptions. It looks at the sound produced by sources not related to transportation equipment. The one exception is that sound produced by transportation equipment while on private property may be regulated by the Noise Control Ordinance. This Ordinance limits the amplitude and duration of sound produced over any given 1-hour period, including the maximum sound level. Sound limits are based on the type of source, the duration of the sound, the time of day of occurrence, background sound levels and the tonal content of sound. The Noise Ordinance applies a 5 dB penalty to the limits given in Table II when the sound is comprised mainly of speech or music or if it contains pure tones or impact sounds. When background sound levels equal the limits given in Table II for the individual categories, the limit of that category is raised in 5 dB increments to encompass the background sound level with one exception. The maximum background sound level is the exception to this rule. If the maximum background sound level exceeds the limit given in Table II, the measured values become the new limit. This process for handling background sound levels and changes in the noise limits creates conflicts. For example, if the measured background L_{50} sound level was 56 dB and the background L_{25} sound level was 58 dB, the revised limit for each would be 60 dB. However, the ordinance would then say that 60 dB could not be exceeded more than 15 minutes and for more than 30 minutes in an hour. Both requirements cannot be met simultaneously. Sources other than heating, ventilating and air-conditioning equipment are regulated by limits given in Table II. Mechanical equipment used for air-conditioning is allowed to make a maximum of 55 dB(A) over the full 24-hours. These limits would apply to activity at the nearby shopping center when measured at the proposed residential property.

TABLE II. Noise Ordinance Limits for the City of Rancho Cordova for Residential Property Affected by Non-Transportation Sources.

		Exterior Sound Level Limits, dB(A)			
		Without Penalty		With Penalty	
Category	Cumulative Number of Minutes in any 1-hour period	Daytime 7 a.m. to 10 p.m.	Nighttime 10 p.m. to 7 a.m.	Daytime 7 a.m. to 10 p.m.	Nighttime 10 p.m. to 7 a.m.
1	30 (L_{50})	55	50	50	45
2	15 (L_{25})	60	55	55	50
3	5 (L_{08})	65	60	60	55
4	1 (L_{02})	70	65	65	60
5	0 (L_{MAX})	75	70	70	65

- Penalty applies when sound is composed primarily of speech or music, contains pure tones or results from impacts or impulsive sources.

2.5 State of California

Title 24 of the State Building Code [5] establish standards governing acceptable interior noise exposures that apply to all new multi-family residential units or new single-family attached residnetial units in California. Buildings proposed in areas where the existing L_{dn} sound level exceeds 60 dB(A) must have an acoustical study performed before construction begins. This noise impact study must establish mitigation measures that will limit interior L_{dn} sound levels to 45 dB(A) in all habitable rooms.

3.0 PROJECT DESCRIPTION & SITE

A multi-use development is proposed for vacant lot east of Bradshaw Road and north of Old Placerville Road. This multi-use development will include four office buildings at the south end of the project and residential housing on the north portion of the project site. Twenty-seven detached single-family homes and eight single-family attached homes are proposed. All single-family detached homes will be two story designs with all the bedrooms on the second floor. The first floor will be living areas and a garage. The attached single-family homes will have bedrooms on both the first and second stories.

The project is bordered by Old Placerville Road on the south side and residential property on the north and east sides. Residential property is found south of the site across Old Placerville Road. A commercial and retail site is west of the project site and includes a supermarket. The supermarket faces west with two loading docks on the east side of the building and a cooling tower on the lower roof at the southeast corner of the buildings. The loading docks are less than 70 feet west of the west property line of the project. A dilapidated eight foot tall wood fence separates the project site from the neighboring commercial property. A six foot tall wood fence separates the project site from the residential property to the north and east. A temporary chainlink fence runs along the south property line. The project site is mostly flat and covered with trees and tall grass. Some undulations in the land are found that limit the visibility of Old Placerville Road from positions near the north end.

Construction of the residential portion of the project is expected to follow a common scheme. Typical exterior wall construction consists of 3-coat stucco finish or cementitious board over $^{7}/_{16}$" thick plywood, 2 x 4 wood studs with R-13 insulation in the stud cavities, and $^{1}/_{2}$" gypsum board attached to the inside face of the studs. The ceilings of all living units will be finished with gypsum board. The ceiling height was assumed to be 9 feet. Double glazed windows will be used throughout all the homes.

Office building construction has not been fully described. The basic design calls for a combination of glass and stone veneers with some stucco. All building will be one story. Mechanical units will be installed on the ground near each office building. Buildings 1 and 2 will be closest to the residences. The mechanical unit for Building 1 is proposed to be on the east side of the building about 80 feet south of the nearest residential property. The mechanical equipment will be on the north side of Building 2, in a jog in the building. These units will be about 70 feet south of the nearest residential property. Parking will surround the buildings.

4.0 TEST EQUIPMENT & PROCEDURES

Standard sound measuring equipment was used during the tests. Field sound measurements were made using a CEL 593 (s/n 3/0201692) Sound Analyzer, two CEL 480, (s/n 129858 and s/n 2/112179), Sound Level Meters and a Larson Davis LD700 (s/n 1455). All meters employ ½ inch random incidence condenser microphones. A CEL Type 284/2 calibrator was used to calibrate the meters and the microphones to 114 dB at 1,000 Hz before beginning measurements. These meters conform to the requirements of a Type I meter per American National Standards Institute, ANSI [7]. A windscreen covered each microphone during all sound measurements. All meters can measure statistical sound levels such as the L_{10}, L_{25}, L_{50} and L_{90}. These are, respectively, the sound levels exceeded 10 percent, 25 percent, 50 percent and 90 percent of the time. The sound level meters also capture the maximum sound level, L_{MAX} and the average sound level, L_{eq}. The CEL 593 meters were used to collect representative sound level tones in one-third octave bands.

Field sound measurements were made on April 18, 2006 between 6:05 a.m. and 9:00 a.m. at the proposed site for the multi-use development. Average sound levels, L_{eq}, were measured to use as a basis for building an accurate model of the sound generated by transportation sources. This field tested model predicts the day-night average sound levels for existing and future conditions. Other statistical descriptors of the sound, labeled L_x, and the maximum sound level, L_{MAX}, were also measured. Here, L_x represents values such as the L_{50} or L_{25}, the sound level exceeded 50 percent of the time or 25 percent of the time, respectively. These give additional information about how sound varied over the test period. That is, it can tell you whether it was a source that was near the site for only a short time or a source that continued over substantial time.

Long-term measurements were made at three positions with microphones mounted on tripods 5.5 to 6 feet above ground level. Sound levels were measured during consecutive five minute intervals to identify sources and variations in sound with time. Sound levels were also sampled every five seconds. A summary description of each position follows:

1. Position #1: 21 feet east of the west fence and 220 feet south of the north fence.
2. Position #2: 12 feet east of the west fence and 330 feet south of the north fence.

3. Position #3: 50 feet north of Old Placerville Road and 80 feet west of the east property line.

Short-interval measurements were made at nine other positions using the CEL 593. These measurements were made to learn additional information about the sound generated by loading dock activity and the cooling towers and the supermarket to the west of the project site. Measurements were made at four positions at the rear of the supermarket with an unobstructed view of the docks and cooling towers. Five additional test positions were on the project site at various distance and positions relative to the cooling towers and loading docks.

5.0 SOUND SOURCES

5.1 Existing

US 50 and Old Placerville Road traffic, activity at the supermarket, mechanical equipment at the supermarket and general aircraft overflights are the major sound sources at the project site. Traffic on US 50 is the dominant sound source in the residential areas with significant contributions from loading dock activity, vehicle movements and the cooling towers. Loading dock activity includes both heavy and medium trucks unloading products. Hand carts, roll carts and electric forklifts were used to move the products and pallets. Trucks entering and departing the dock area generate significant sound. At present, the dock does not open before 6:00 a.m. Occasionally, a truck may come in and wait until the docks open to permit unloading. Signs are posted to prevent drivers from idling the engines while waiting. Except when a driver left the cab to open the trailer doors, all trucks shut off their engines while unloading. A total of 10 heavy trucks could unload between 6:00 a.m. and 4:00 p.m. Most deliveries are made between 6:00 a.m. and 9:00 a.m. A few vehicles driving past the dock area were important sources also. Two cooling towers mounted on the lower roof of the supermarket are important sources and appear run continuously. The project site is within 10,000 feet of Mather Airport. Single and multi-engine propeller aircraft and jets were observed flying over the project site though the CLUP documents for the airport do not show this as a standard departure path. Other sound sources include dogs barking and general human activity on the surrounding property.

The south part of the project site, the area to be used for office buildings, is primarily impacted by traffic on Old Placerville Road with some contribution from US 50 traffic. Entering or departing trucks from the retail site to the west may have a small influence on the sound levels at the building near the west side.

Old Placerville Road is an important east-west street running along the south side of the project site. This road stretches from Bradshaw Road west of the project to Rockingham Drive northeast of the project. Old Placerville Road is two-lanes in each direction near the project site with a turning lane in the middle. Traffic counts were taken from the Traffic Volume Flow Map published by the County of Sacramento in 2005 [8]. Spot counts were not made during the field tests to assess traffic mixes. Traffic speeds were observed to be between 50 and 55 MPH. Heavy truck volumes are relatively low because Old Placerville Road is not a primary thoroughfare. US 50 is a major east-west freeway providing connections between Sacramento and the communities to the east. This road comprises three lanes in each direction near the site. Speeds vary from 60 to 80 MPH. Traffic volumes and mixes were taken from CalTrans' publications on the internet [9,10]. Table III summarizes the data used to calculate existing day-night average sound levels.

TABLE III. Roadway Traffic Volumes and Mixes Assumed to Calculate Existing Day-Night Average Sound Levels for Proposed Residential Property in Rancho Cordova.

Road Name	Distance to Near Lane, Ft	Average Daily Volume	Percent Heavy Trucks	Percent Medium Trucks	Percent Trucks at Night	Percent Autos at Night	Vehicle Speed MPH
Old Placerville Road	>270	20,500	2.0	2.5	8.0	12.0	55/50
US 50	2,500	185,700	2.5	2.1	10.0	13.0	65/60

-Automobile and truck speed respectively

5.2 Cumulative + Project

The dominant sound sources at the project site will remain the same for cumulative plus project conditions. Traffic on Old Placerville Road will be an important source at the proposed offices but less important at the residential property. Traffic on US 50 is expected to continue to be the principal background sound source at the project site. The cooling towers, loading dock activity, truck movements and vehicle passages at the east side of the retail store will continue to be an important sound source for the homes closest the west property line. Truck movements and dock activity were assumed to remain at current levels. Aircraft flight paths are expected to remain similar to existing conditions so this will remain a sound source. Sound associated with the proposed office buildings on the project site is not expected to impact the proposed residential property to the north. The office buildings will introduce HVAC equipment, additional traffic and human activity. Other sources remain secondary in importance. Quantifying the other sources is very difficult.

Projected future traffic volumes on Old Placerville Road were calculated using the values from Table III and a 2 percent rate of growth [8]. A similar growth rate was assumed of US 50. Traffic speeds and mixes were assumed to remain about the same for both roads. A summary follows in Table IV of road traffic volumes used to compute L_{dn} sound levels for cumulative plus project conditions.

TABLE IV. Roadway Traffic Volumes and Mixes Assumed to Calculate Cumulative Plus Project Day-Night Average Sound Levels for Proposed Residential Property in Rancho Cordova.

Road Name	Distance to Near Lane, Ft	Average Daily Volume	Percent Heavy Trucks	Percent Medium Trucks	Percent Trucks at Night	Percent Autos at Night	Vehicle Speed MPH
Old Placerville Road	>270	30,500	2.0	2.5	8.0	12.0	55/50
US 50	2,500	275,900	2.5	2.1	10.0	13.0	65/60

-Automobile and truck speed respectively

6.0 EXTERIOR ACOUSTIC ENVIRONMENT

6.1 Existing

Field sound measurements at the project site were used to evaluate the existing acoustic environment. Averages of the 5-minute test samples were computed for each hour or part of an hour. Averages of the short interval sound levels and other statistical descriptors are given in Table V along with the predicted L_{eq} sound levels. Calculations of predicted hourly noise levels were made using the Federal Highway Administration (FHWA) Highway Noise Prediction Model [11]. The FHWA model was modified to include the CalTrans noise emission levels [12]. This model assumes freely flowing traffic. The ground was assumed to be acoustically soft for all sources because of the influence of the grass at the measurement positions. Road visibility and ground conditions were considered in calculations of the hourly average sound levels at each test position. The influence of temperature was also considered. The predictions do not consider the influence of traffic on US 50. The distance between the site and US 50 limits the accuracy of the model.

TABLE V. Sound Levels Measured at Three Positions for a Proposed Multi-Use Development on Old Placerville Road in Rancho Cordova and Comparisons with Predicted Average Sound Levels Due to Traffic on Old Placerville Road.

		Measured Sound Level, dB(A)							Predicted
Position	Time, a.m.	L_{MAX}	$L_{1.7}$	$L_{8.3}$	L_{25}	L_{50}	L_{90}	L_{eq}	L_{eq}, dB(A)
#1	6:05-7:00	76	66	60	58	58	56	59	52
	7:00-8:00	70	60	57	56	55	53	56	52
	8:00-9:00	74	61	56	54	53	52	55	51
Total Time	*6:05-9:00*	*76*	*63*	*59*	*57*	*55*	*53*	*57*	—
#2	6:30-7:00	78	68	61	58	57	56	60	54
	7:00-8:00	69	60	57	56	55	53	56	54
	8:00-9:00	74	61	56	54	53	52	55	53
Total Time	*6:30-9:00*	*78*	*63*	*58*	*56*	*55*	*52*	*57*	—
#3	6:15-7:00	80	—	73	71	69	63	70	70
	7:00-8:00	78	—	73	71	69	63	70	70
	8:00-9:00	77	—	72	70	68	61	69	69
	9:00-9:35	80	—	71	68	64	56	67	—
Total Time	*6:15-9:35*	*80*	—	*73*	*71*	*68*	*60*	*69*	—

Average sound levels at Positions #1 and #2 decreased with time while the levels were fairly constant at Position #3 according to Table V. This table also shows that the measured and predicted L_{eq} sound levels do not agree well for Positions #1 and #2. Again, these predictions do not include the influence of traffic on US 50. Traffic volumes would be expected to be greater on both US 50 and Old Placerville Road from 7:00 a.m. to 8:00 a.m. than from 6:00 a.m. to 7:00 a.m. However, the L_{eq} sound

levels are decreasing. This could means that non-transportation sound sources at the retail site influenced the results or that some other factor affected the results. In this case, the change in the temperature appears to be the reason for the change. As the sun comes up and the ground warms, sound rays tend to bend toward the sky rather than propagating close to the ground. Because of the large distance, this has a large influence on noise from traffic on US 50. The cooling towers ran continuously, so this could not have been a factor in the changing sound at Positions #1 and #2. Two heavy trucks were operating at the docks during the time before 7:00 a.m. and after 7:00 a.m. Thus, this too does not appear to be the dominant source. This data shows that traffic on Old Placerville Road is not the dominant source. The predicted L_{eq} sound level due to traffic on US 50 from 6:00 a.m. to 7:00 a.m. with an inversion was 58 dB. With the influence of Old Placerville Road, the total L_{dn} sound level would be 59 dB. This agrees well with the measured value. Thus, sound at Positions #1 and #2 are a function of road traffic and an acceptable model can be made.

A comparison of the average, maximum and sound level exceeded 90 percent of the time at Positions #1 and #2 is presented in Figure 1. The results are nearly identical even though the Position #2 was 110 feet south of Position #1 and 9 feet closer to the west fence. Position #1 was far closer to the cooling towers and in a more central position relative to the loading docks. Figure 2 shows how all sound descriptors varied over time at Position #1. The general trend to lower sound levels is seen in this figure, even when traffic on US 50 should have been increasing. Similar results are displayed in Figure 3 for 5-minute measurements made at Position #2. The influence of truck and loading dock activities and of aircraft flights is shown in both figures.

Measured and predicted sound levels at Position #3 agree very well as seen in Table V. This means that traffic on Old Placerville Road was the main sound source at this position and that the influence can be estimated. The variation in the statistical sound descriptors measured at Position #3 is presented in Figure 4 for each five-minute interval. A much larger difference between the L_{90} sound level and the L_{08} sound level is shown in this figure compared with Figures 1 and 2. This implies that the traffic on this road was not continuous and there wee intervals with limited vehicles passing by the site. All sound descriptors were much more constant at this position that at other positions. The short distance between the traffic on Old Placerville Road and the test position was not influence by any inversion. Sound levels did begin to drop after 8:15 a.m., with a big drop after 9:00 a.m. This corresponds to a reduction in traffic.

The non-transportation sound sources at the supermarket must meet limits of the County's Performance Standard and the City's Noise Control Ordinance. Background sound levels are greater than the County's Performance Standard, so knowing whether the existing conditions meet this limit is not possible. Figure 2 shows maximum sound levels at Position #1 due to a medium delivery truck of 72 dB(A). The City's L_{MAX} limit is 75 dB(A) if a pure tone is not present and 70 dB(A) if a pure tone is present. The delivery van (medium truck) did produce a pure tone even when averaged over 15 seconds as seen in Figure 5. The pure tones at 100 and 125 Hz (cycles/second) were due to the vehicle while the pure tone at 16 Hz was due to a background source that was still present after the van left. Thus, sound from this vehicle exceeded the City's limit even when measured 21 feet east of the property line. The L_{MAX} sound level two feet east of the west property line would be predicted to be at least 5 dB(A) higher. This would exceed the limit even without the pure tone penalty if the tone were not present. The heavy delivery trucks also generate pure tones as presented in Figure 6. These measurements were made as the truck pulled out from the dock and then after it turned around to pass back by the dock to exit onto Old Placerville Road. The pure tones are related to engine firing and exhaust.

The two cooling towers on the roof of the supermarket are shielded to the north and northeast by a metal sound barrier. This barrier was installed because of complaints from the homes to the north. Because of high background sound levels during the tests, differentiating between traffic and cooling towers is difficult. Figure 7 displays the sound tones measured at four positions with the cooling tower and road traffic the only significant sources. The measurement at Positions #8 and #9 were made close to 7:00 a.m. when traffic noise was still high. This figure shows no change in sound amplitude below 630 Hz when the test position moved an additional 15 feet, 60 versus 75 feet from the face of building supporting the towers, and the wood fence intervened. This suggests that the unchanged sound was due to traffic while the wood fence reduced the upper frequencies. Under ideal conditions, the sound would have decreased 1.5 to 2.0 dB at all frequencies because of the increased distance. Additional measurements were made after 8:00 a.m. on the project site after traffic influences had decreased. Positions #10 and #11 were selected so the fence did not shield the microphone. Position #10 was 42 feet east of the fence while Position #11 was only 27 feet east of the fence. A 1 dB(A) difference would be expected, but the results are almost identical. The fence may have provided some shielding at Position #11. The cooling tower runs almost continuously and for long periods of time. The nighttime limit for the L_{50} sound level is 50 dB(A). The lowest level measured was 53 dB(A). Some of this sound was due to traffic because the exact contribution is unknown. The possibility exists that the sound from the cooling towers would exceed the City's limit when traffic noise from US 50 was very low. This would most likely occur on very hot evenings for existing conditions.

The FHWA traffic noise model [6] was used to predict existing day-night average sound levels at the three main test positions. Traffic on both US 50 and Old Placerville Road was included in the model, one road at time. The ground was assumed to be acoustically soft for all traffic sources including automobiles, medium trucks and heavy trucks for both roads. The influence of the tall grass was ignored. Road visibility was considered in the calculations and it was assumed that temperature gradients did not cause excess attenuation or focusing. Table VI gives the predicted day-night average sound levels at Positions #1, #2 and #3 based on traffic volumes given in Table III and the assumptions stated above. The influence of aircraft traffic out o Mather field was included in the "Other Sources". The project but is outside the 60 CNEL contour and was assumed to be an L_{dn}/CNEL value of 52. "Other Sources" also includes sound generated by activities at the retail center west of the site.

TABLE VI. Predicted Day-Night Sound Levels for Existing Conditions at Measurement Position #1 and #2 at Project Site along Bradshaw and Gerber Roads in Sacramento County.

Receiver Position	Predicted L_{dn} Sound Level, dB			Total L_{dn}, dB, All Sources
	US 50 Traffic	Old Placerville Road Traffic	Other Sources	
#1	57	54	61	63
#2	57	55	60	63
#3	56	71	52	71

Existing day-night average sound levels are classified as "Normally Acceptable" for residential at test Positions #1 and #2. Existing day-night average sound levels are classified as "Normally Unacceptable " for test Position #3. These classifications apply to property used for residential development. Backyard day-night average sound levels could be expected to be in the "Conditionally Accept-

able" range for positions closer to the south edge of the proposed residential property. Higher backyard day-night average sound levels could be expected in the area proposed for office buildings. This result does not include the influence of a sound wall or shielding from buildings that could be built along Old Placerville Road.

6.2 Cumulative + Project

Traffic on US 50 and Old Placerville Road will dominate the acoustic environment to the year 2026 at the project site. The office buildings will subjected to sound mainly from Old Placerville Road. The worse case hourly L_{eq} sound level is of interest at the face of the offices because the County's Noise Element sets interior limits for normal hours of operation. Non-transportation sound sources influencing the residential portion of the project include the cooling towers at the supermarket, dock and vehicle activity on the east face of the market, mechanical equipment at the new office building part of the project and vehicle movements around these offices. These sources are discussed in the following paragraphs.

Traffic volumes on US 50 and Old Placerville Road will increase over the next 20 years. Because of the distance over which the sound propagates from US 50, the acoustical characteristics of the ground will remain the same. However, the residential and office building development at the site will change the characteristics of the ground between Old Placerville and the offices and the residences. Sound levels were predicted at two residential lots that represent the two worse case conditions. Lot 8 is near the northwest corner of the project, directly east of the loading docks and cooling towers at the supermarket. The second prediction site is Lot 23 at the southeast corner of the residential development. This site has a view of Old Placerville Road, but substantial shielding to the southwest and the southeast because of the new office buildings and the existing apartment buildings. Table VII presents the predicted L_{dn} sound level at these two residential lots. Other sources at Lot 8 include the cooling towers and all dock activity.

TABLE VII. Predicted Day-Night Sound Levels for Cumulative Plus Project Conditions at The Nearest Proposed Backyard to Old Placerville Road in Rancho Cordova.

Receiver Position	Predicted L_{dn} Sound Level, dB			Total L_{dn}, dB, All Sources
	US 50 Traffic	Old Placerville Road Traffic	Other Sources	
Lot 8, NW	59	53	61	64
Lot 23, SE	58	60	53	63

The predicted L_{dn} sound level falls into the "Conditionally Acceptable" regions of land use compatibility at both sites. Traffic on US 50 is the major source at Lot 8 with a small contribution from other sources including Old Placerville Road traffic. Vehicles on Old Placerville Road are the major source of sound at Lot 23, but US 50 traffic has a significant influence also. Additional sound reduction is not feasible. The predicted backyard L_{dn} sound levels are less than the County's limit for the L_{dn} sound level of 65 dB.

The residential portion of the project is estimated to generate 350 car trips per day on Old Placerville Road while the cumulative traffic volume is expected to be 30,500. This will increase the L_{dn} sound level by less than 0.3 dB. The office portion of the project is estimated to generate 400 additional car trips per day. Without this project, the cumulative ADT is predicted to be 30,500. Again, this changes the L_{dn} sound level by less than 0.3 dB.

The non-transportation sound sources and transportation sources while on private property must meet the limits of the County's Performance Standard of the Noise Element and the Cities Noise Control Ordinance. Both sets of limits are based on the sound measured during any 1-hour period. An assumption was made that changes would not be made in the number of dock events or the number of vehicles passing by the east side of the supermarket that is next to the west property line of the project site. General dock activity, truck passage, other vehicle passage, waste compaction and operation of the cooling towers are considered the primary the major sources influencing the homes along the west property line. At present, an 8-foot tall wood fence runs along the west property line. This fence is down in some locations and has many spaces between boards. The gaps reduce the sound reduction capability of the wall to 3 to 5 dB(A). An assumption was made that this fence will be replaced with a minimum 8-foot masonry fence or equivalent. Each source is discussed below assuming this fence is in place.

Sound generated by the cooling towers on the roof of the supermarket is not expected to change from current levels. The existing tests were inconclusive regarding the exact sound levels produced by the two cooling towers. Background sound from US 50 masks the sound from the cooling towers. Whether the load on the cooling towers changed also is unknown. The cooling towers are approximately 25 feet above ground level on a lower roof section on the supermarket. An existing sound barrier along the north and part of the east side of the roof shields the cooling towers from the residences to the north and northeast. For the assumed tower height, a 5.5 foot tall person would have to be more than 9 feet behind the wall to see the top of the tower. The predicted sound level at this positions is between 52 and 56 dB(A). Both values exceed the City's L_{50} sound level limit of 50 dB(A) at night. The County's Performance Standard of 45 dB(A) for the L_{50} sound level also is exceeded. If background L_{50} sound levels were always as high as measured during the field tests, the City's limit would increase to 60 dB(A), and the sound would comply. Additional sound reduction could be achieved by extending the sound wall on the roof to the south edge of the roof and then possibly along the south edge of the roof or by increasing the height of the sound wall at least two feet. Because of the uncertainty as to actual sound generated by the cooling tower, additional sound reduction may not be warranted.

Heavy and medium trucks entering and leaving the dock area and the passage of other vehicles are significant sound sources at proposed residential areas. The number of events per hour or duration of each event is ill defined at best. An assumption was made that three heavy and two medium trucks would enter and leave the dock area between 6:00 a.m. and 7:00 a.m. That engines would be turned off while at the docks or waiting to get to the docks was assumed also. An assumption was made that trucks might leave their engines on while getting out of the truck to open the trailer doors before backing into the dock. Figure 6 presents the 15-second average sound level measured as a heavy truck pulled out of a dock and then while driving by the dock after turning around and departing south. The 30-second average sound level was 75 dB(A) when measured at approximately 8 feet. Previous measurements of a truck driving at a constant speed past a test position showed sound levels of 71 dB(A) when tested a distance of 18 feet from the centerline of the truck path. The distance from the

microphone is constantly changing as the vehicle moves. The measured sound level of the same truck departing was approximately 84 dB(A) at the same distance because of increased engine speed and load. These three results were used to estimate sound level at the nearest residences. The noise source for the heavy trucks is assumed to be the exhaust at height of 8 feet above ground level. For heavy trucks with mufflers under the frame and moving at constant speed, the engine may be the main source and this is only 5 feet above ground level.

The predicted $L_{1.7}$ sound level is greater than the 60 dB(A) nighttime limit with the assumptions made and assuming a pure tone is produced. A wall height of 10 feet is required to reduce the $L_{1.7}$ sound level under these conditions to less than the limit. These calculations assume that trucks are not left idling. Background sound levels were assumed to be below the existing nighttime limit when a pure tone is present.

Sound generated by other dock activities primarily involves impulsive sounds such as dropping pallets, banging metal doors and similar sources. Because these occur randomly, separating them from other data is very difficult. Based on the assumptions made, erecting the 10-foot sound wall along the perimeter will result in acceptable levels in the residential area.

Mechanical equipment and general activity in the office development portion of this project was evaluated also. Sound from these sources is not expected to exceed the limits of the City's Noise Control Ordinance. Sound from the mechanical equipment will be well below the City's noise limit. Only a rough estimate can be made of sound from other sources because they are not well defined.

7.0 INTERIOR ACOUSTIC ENVIRONMENT

The State of California assumes that a 15 dB reduction can be expected from the exterior to the interior of a home with the windows open. Thus, any L_{dn} sound level greater than 60 dB(A) will cause interior sound levels to be greater than the 45 dB(A) limit [5,3] if the windows or doors are allowed to be open. An interior day-night average sound level goal of 43 dB is used to evaluate designs. This is the limit when a 2 dB margin of safety is applied to the 45 dB limit. A margin of safety is used because Sound Transmission Class, STC, ratings of building components are based on laboratory tests. Laboratory construction techniques can seldom be duplicated in the field. The State assumes up to a 5 dB reduction in sound loss from the laboratory to the field. The STC rating of building products is used in the calculation of interior L_{dn} sound levels.

Interior L_{dn} sound levels were predicted using the wall design given in Section 3.0 of this report and the architectural drawings [?]. The exterior L_{dn} sound levels given in Table VII were used along with a traffic sound spectrum measured at the project site to calculate interior L_{dn} sound levels. An interior day-night average, L_{dn}, sound level goal of 43 dB was used to evaluate each design. This is the limit when a 2 dB margin of safety is applied to the City of Citrus Heights and State of California's limit of 45 dB. This margin of safety is used because the noise prediction model is only good to ±1.5 dB(A) and because Sound Transmission Class, STC, ratings of building components are based on laboratory tests and construction techniques with quality that can seldom be duplicated in the field. A 5 dB reduction in the sound transmission was assumed because of the source location outdoors with no reflecting surfaces nearby [13]. The sound transmission loss of materials used in exterior constructions was taken from publications by the National Institute of Tests and Standards [14] and the State of

California [15]. Some data was taken from literature published by manufacturers or was predicted from sound transmission loss models. Standard dual glazed windows were assumed for all units.

Exterior L_{dn} sound levels are predicted to be less than 65 dB(A) at any home. This represents the worst case for interior sound levels. This prediction included the effects of shielding from other buildings. With the exterior wall construction given in Section 3.0 and standard windows, the predicted interior L_{dn} is predicted to be less than 40 dB. Upgrades to the exterior wall construction or windows will not be needed. This prediction assumes the exterior wall construction meets the general requirements given in the mitigation section of this report. All units must meet a minimum construction requirement to achieve the L_{dn} sound level design goal and assumptions made in the analyses.

8.0 ACOUSTICAL IMPACTS

8.1 Exterior

The change in exterior L_{dn} sound levels from cumulative to cumulative plus project will have an insignificant impact for the backyards of homes associated with this project. The change from existing to cumulative plus project will also be insignificant. The impact relative to acceptable exterior L_{dn} sound levels in the backyards of homes on all lots will be insignificant. No mitigation will be necessary for the backyards of homes in this project.

Exterior sound levels relative to non-transportation sound limits will be significant in the backyard of homes on the west side of the project. These homes are near two types of non-transportation sound sources. These two sources are the cooling towers at the supermarket and activity associated with deliveries to the supermarket. Mitigation will be required to ensure that the impacts are less than significant.

8.2 Interior

Interior L_{dn} average sound level impacts are insignificant for cumulative plus project conditions for rooms in all proposed homes at the project site. Exterior walls must meet certain minimum acoustical requirements in all units for these conclusions to be correct.

9.0 MITIGATION MEASURES

Exterior sound reduction is required for the backyards of newly constructed homes on the west side of the project site. Exterior sound reduction is not required for the backyards of all other homes. Special sound attenuation is not required to meet the interior L_{dn} sound level goals for rooms in the proposed homes. The following sections discuss the requirements for each area and general requirements for all new homes.

9.1 Exterior

Exterior sound reduction is not required at the residential development to meet the County's Noise Element requirements for transportation sound sources or long duration stationary. This conclusion is based on the predicted L_{dn} sound level in the backyard of all homes. Sound attenuation is needed for non-transportation sources or transportation sources while on the private property at the retail

development west of the project site. For most of the sources at the retail development, erecting a sound wall along the property line will be sufficient to meet the City's Noise Control Ordinance. However, because the cooling tower on the supermarket is elevated, this might not be adequate. Extending the existing sound wall on the roof to fully enclose the towers would probably work better. Three problems exist with this option. First, enclosing the towers might not be allowed because of operating requirements for adequate air might not be met. The second problem exists because the project developer has no control over these units. Finally, because of high background sound levels, that the towers are exceeding the noise limits is not clear. Because of the request for a change in the zoning at the project, who has responsibility for reducing the noise of the towers if need is not clear. An agreement between the supermarket and project owner will likely be required to determine how mitigation will be implemented and how costs will be shared.

I. Exterior Sound Reduction Measures

A. Property Line Sound Wall

1. A 10 foot sound wall shall be constructed.
2. The wall shall extend along the west property line beginning at the northwest corner of the property and terminating 5 feet south of the north face of Office 1.
3. All sound barrier walls must have a minimum surface weight of 3.5 to 4.0 lbs./sq.ft. The sound wall can be constructed from concrete masonry units, other concrete products, wood or metal if the surface density meets the specified limits.
4. The structures must be continuous along their width and height with no gaps including at the ground.
5. All wall heights are referenced from building pad elevation.

B. *Optional Wall at Cooling towers*

1. After the property line sound wall is constructed, measure the sound in backyard area of homes to be built along the west side of the project.
2. Measurements shall be made when background sound levels are the lowest but during hours when the cooling tower is normally running under typical speed and load conditions.
3. The sound wall surrounding the north and northeast portion of the cooling towers at the supermarket shall be extended southward to the corner of the structure and then continue west for 6 feet.
4. The new wall shall be of equal or greater height than the existing wall.

9.2 Interior

General construction requirements for all homes are given below. These general requirements ensure certain minimum construction and acoustic standards are met so the interior L_{dn} sound level predictions will be true for all homes.

I. General Requirements

A. All joints in exterior walls shall be sealed airtight around windows and doors, at the wall perimeter and at major seams.
B. All above ground penetrations of exterior walls by electrical and plumbing components shall include a $^{1}/_{4}$ to ½ inch airspace around the perimeter. This space shall be filled loosely with fiberglass insulation. The space shall then be sealed airtight on both sides of the wall with a resilient, non-hardening caulking or mastic.
C. Basic exterior wall construction shall comprise the following material of equal surface weight and Sound Transmission Class, STC rating.

1. Minimum 2" x 4" wood studs at 16 or 24 inches on center.
2. Minimum R-13 insulation in the stud cavities,
3. ½" gypsum wallboard fastened to the interior face of the wood studs. The wall shall be fully taped and finished, and sealed around the perimeter with a combination of backer rod and resilient, non-hardening caulking,
4. The exterior surface shall be finished with the following or with another product with equal or greater surface weight.

a. Finished with a dense 3-coat, stucco over wire mesh and building paper,

OR

b. Cementitious board over minimum $^{7}/_{16}$" thick plywood,

OR

c. Combination of these two finishes may be used in different parts of the same home.

D. Ceilings shall be finished with a minimum ½" gypsum board with minimum R-19 insulation in the ceiling.
E. Windows shall have a minimum STC rating of 29 or better. Windows shall have an air infiltration rate of less than or equal to 0.20 CFM/lin. ft. when tested with a 25 mile an hour wind per ASTM standards.
F. There shall be no need to open windows, doors or other exterior openings to provide adequate ventilation.

10.0 REFERENCES

1. Anon., "Noise Control," SCC No. 254, adding Chapter 6.68, Revised April 15, 1987, Rancho Cordova.

2. P. Johns, General Plan Manager, ***Draft General Plan, City of Rancho Cordova***, released March 13, 2006 for public review.

3. Anon., "Noise Element of the County of Sacramento General Plan", from the County of Sacramento General Plan, December 15, 1993.

4. Anon., "Noise Control," SCC No. 254, adding Chapter 6.68, Revised April 15, 1987, County of Sacramento.

5. State Building Code, "Sound Transmission Control", Part 2, Title 24, C.B.C., Appendix Chapter 12, January 2002.

6. Anon, "Old Placerville Road", architectural drawings and site plans of residential and office development, prepared for Tower Development by Loving & Campos Architects Inc., Walnut creek, Project No. 05013, March 20, 2006.

7. American National Standards Institute, ANSI, ***Standard Specification for Sound Level Meters, S1.4-1983 (Precision)***

8. Sacramento County, Transportation Division, http://www.sacdot.com/services/Traffic_Counts.asp, May 26, 2005.

9. California Department of Motor Vehicles, Traffic and Vehicle Data Systems Unit, "2004AADT", http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/2004all/docs/2004aadt.xls , US50 East of US99, 2004

10. California Department of Motor Vehicles, Traffic and Vehicle Data Systems Unit, "2004AAD Truck Traffic", http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/truck2004final.pdf, 2004

11. T.M. Barry & J.A. Readgan, ***FHWA Highway Traffic Noise Prediction Model***, FHWA-Rd-77-108, Federal Highway Administration, Office of Research, Office of Environmental Policy, December 1978.

12. R.W. Hendriks, ***California Vehicle Noise Emission Levels***, FHWA/CA/TL-87/03, Office of Transportation Laboratory, California, Department of Transportation, Sacramento, California, 95819, January 1987.

13. G.E. Mange, S.R. Skale, L.C. Sutherland, ***Background Report On Outdoor-Indoor Noise Reduction Calculation Procedures Employing The Exterior Wall Noise Reduction (EWNR) Method***, FHWA Report TS-77-220; March 1978.

14. Anon., ***Acoustical and Thermal Performance of Exterior Residential Walls, Doors and Windows***, NBS Building Science Series 77, National Bureau of Standards (National Institute of Tests and Standards), Department of Commerce, 1975.

15. R. DuPree, ***Catalog of STC and IIC Ratings For Wall and Floor/Ceiling Assemblies with TL and ISPL Data Plots***, Office of Noise Control, California Department of Health Services, Berkeley, California, 1981.

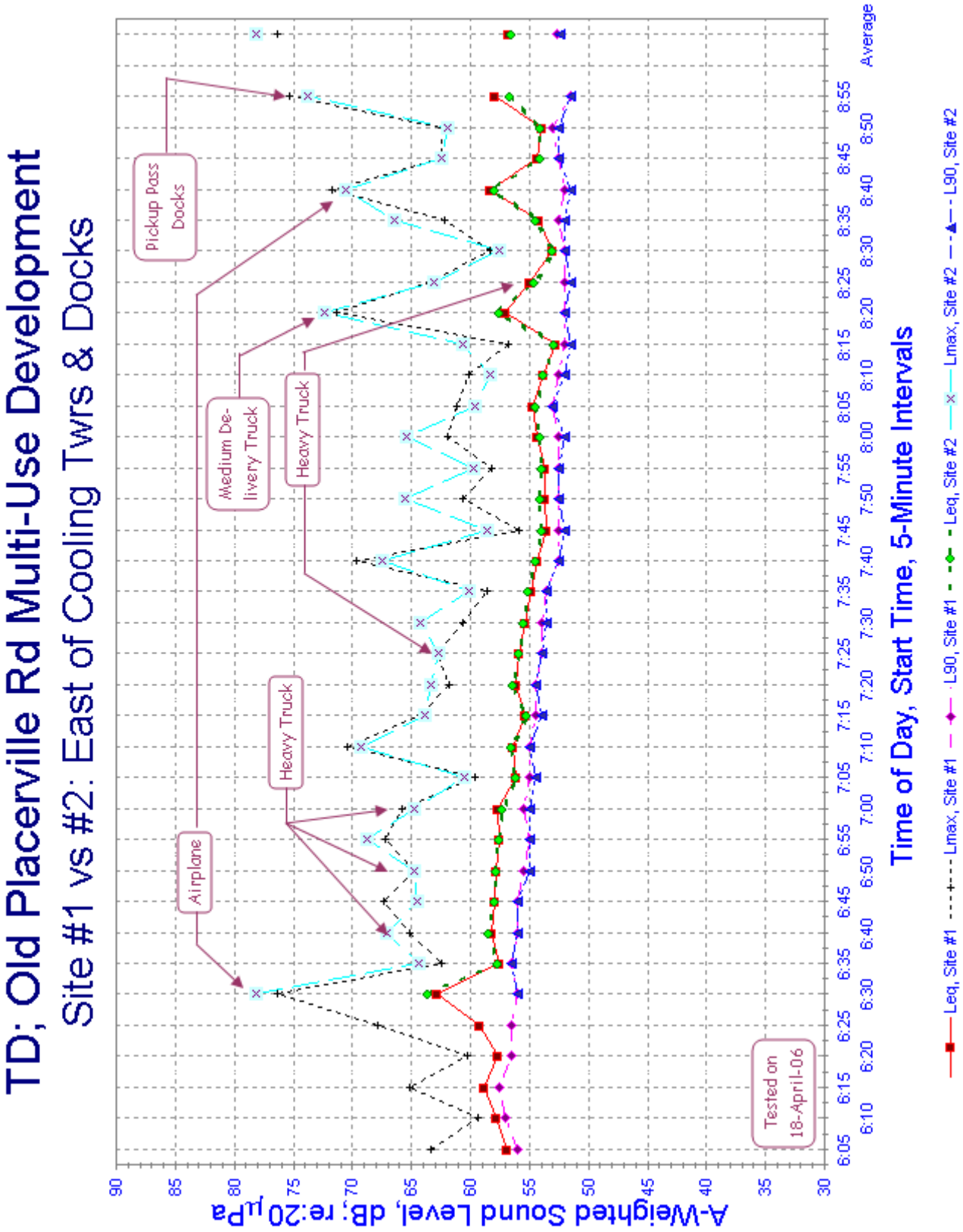

Figure 1. Comparison of L_{eq}, L_{MAX} and L_{90} Sound Level at Positions #1 and #2 During Each 5-Minute Interval.

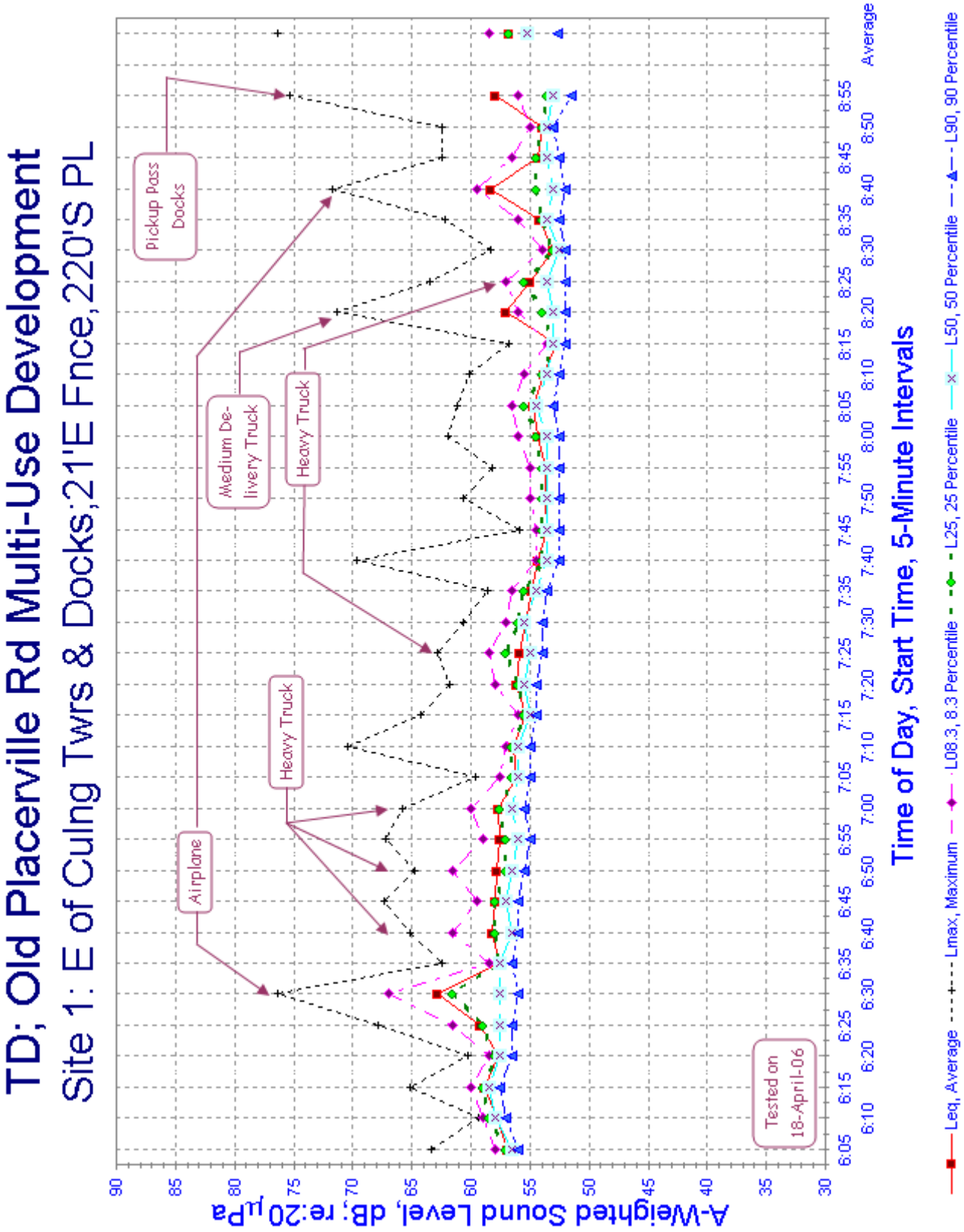

Figure 2. Variation in Sound Measured in 5-minute Intervals at Position #1, East of the Loading Docks of Retail Store.

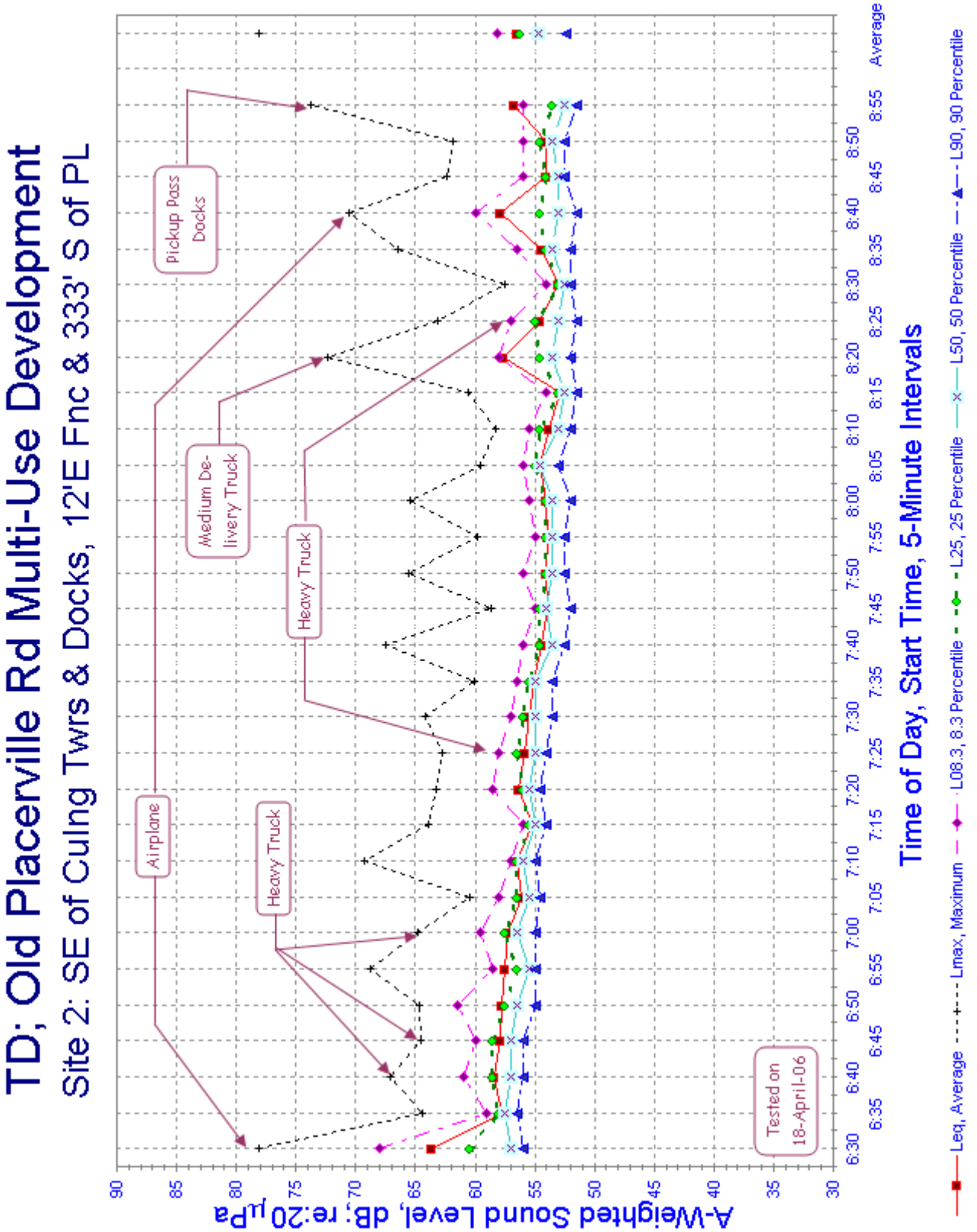

Figure 3. Sound Variations in 5-minute Intervals at Position #2 Near the South Loading Dock of the Supermarket.

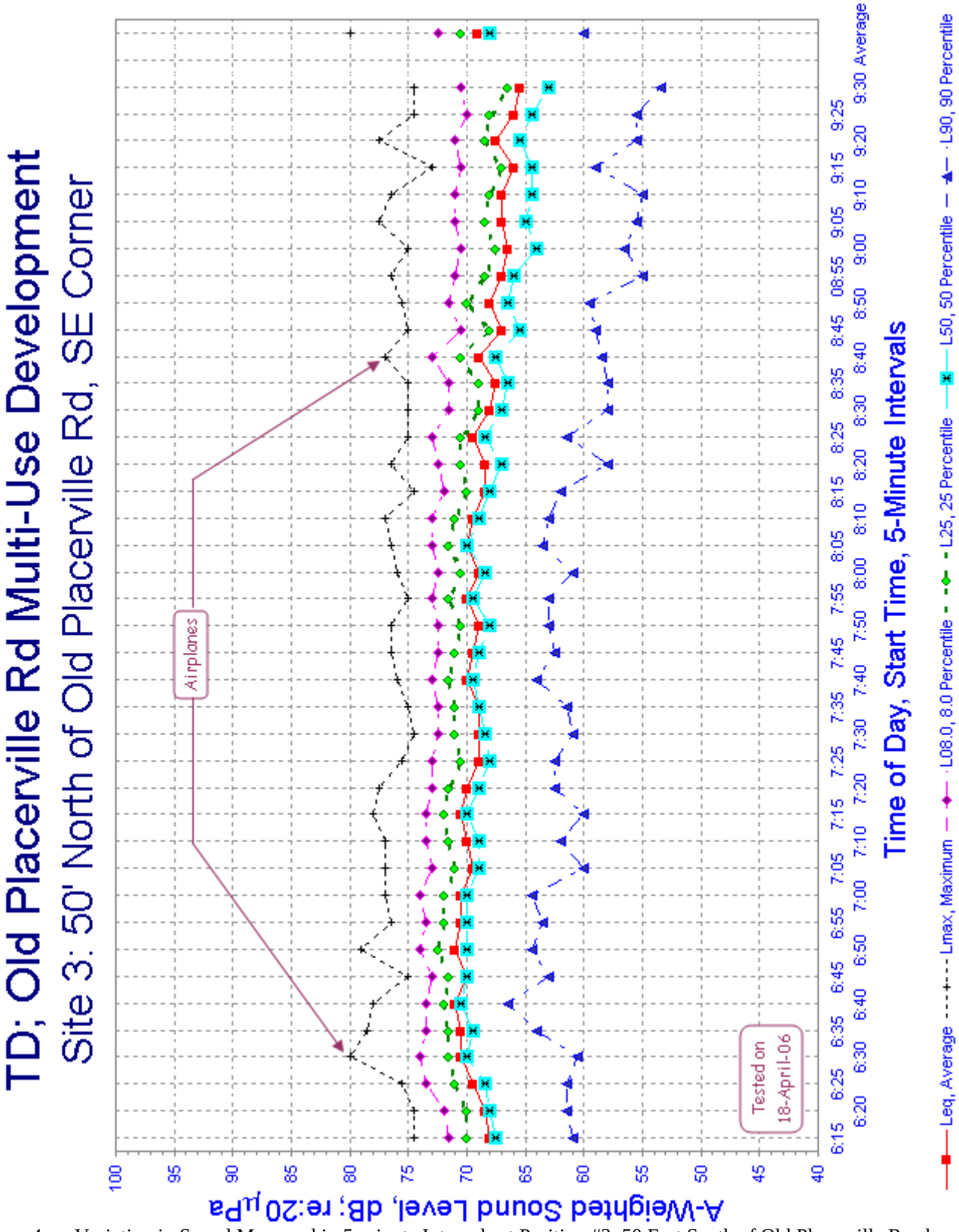

Figure 4. Variation in Sound Measured in 5-minute Intervals at Position #3, 50 Feet South of Old Placerville Road.

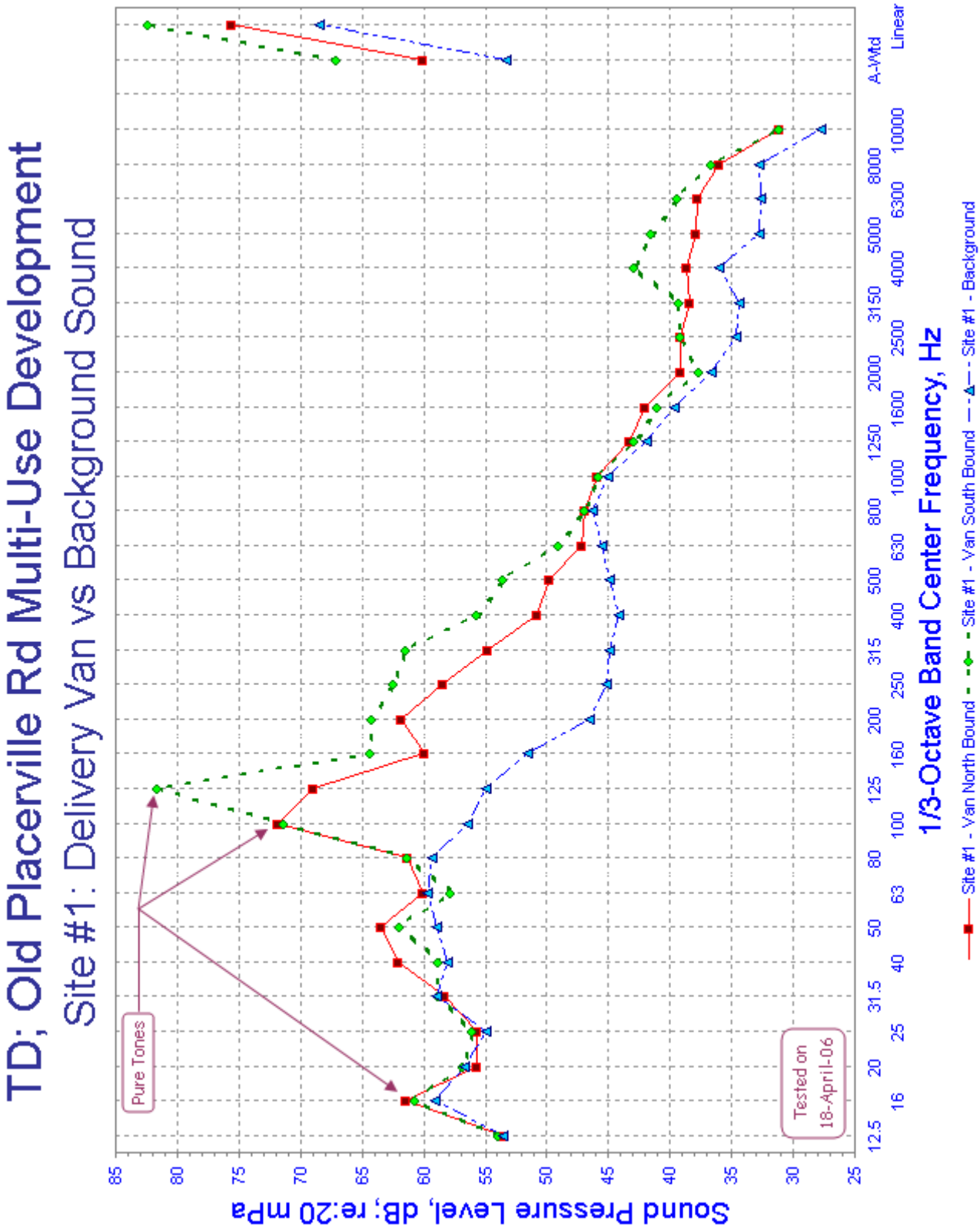

Figure 5. Tonal Content of Medium Truck Leading Supermarket Docket Area When Measured at Positions #1.

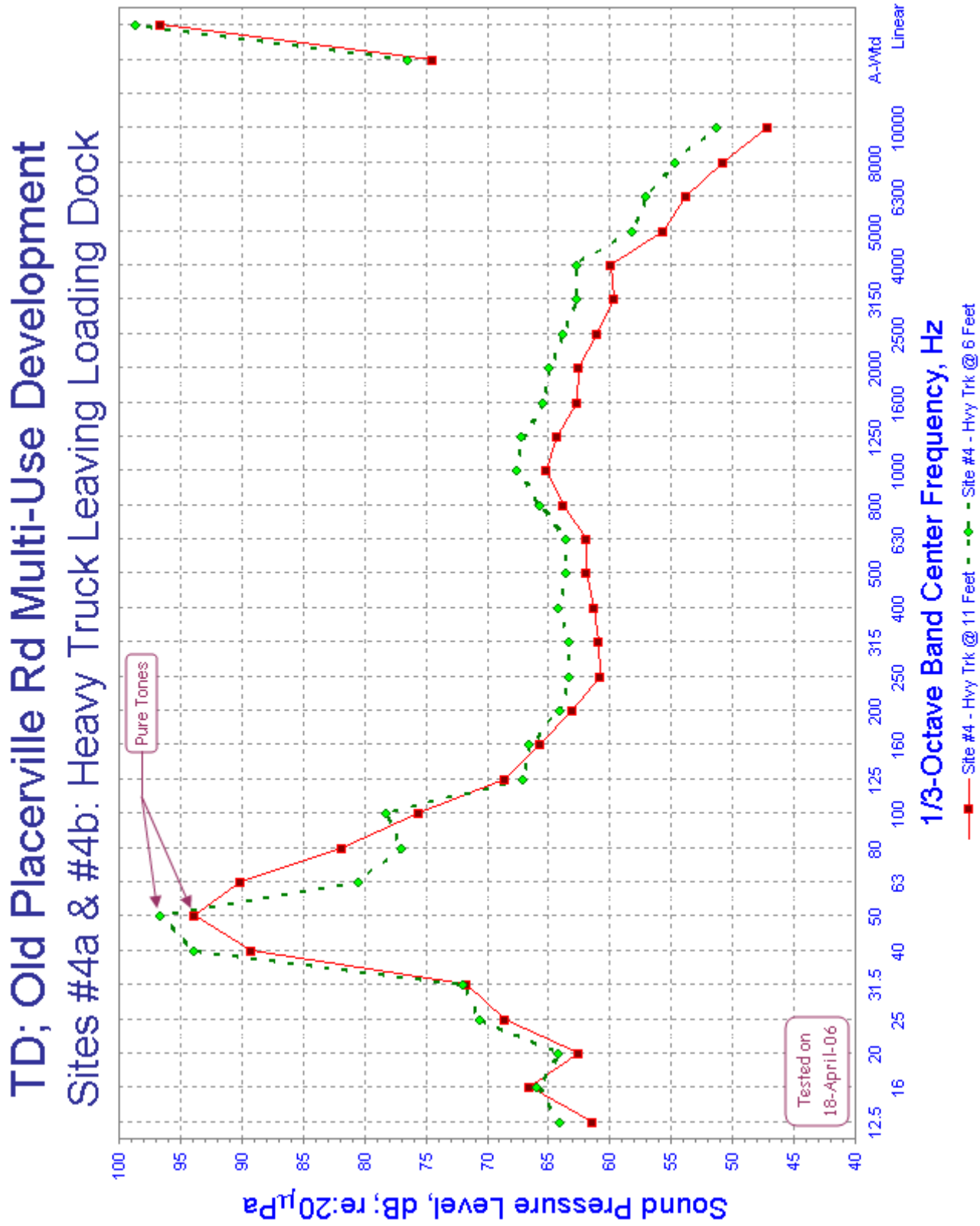

Figure 6. Comparison of 15-Second Average Tonal Content of Heavy Truck Leaving Supermarket Dock Area.

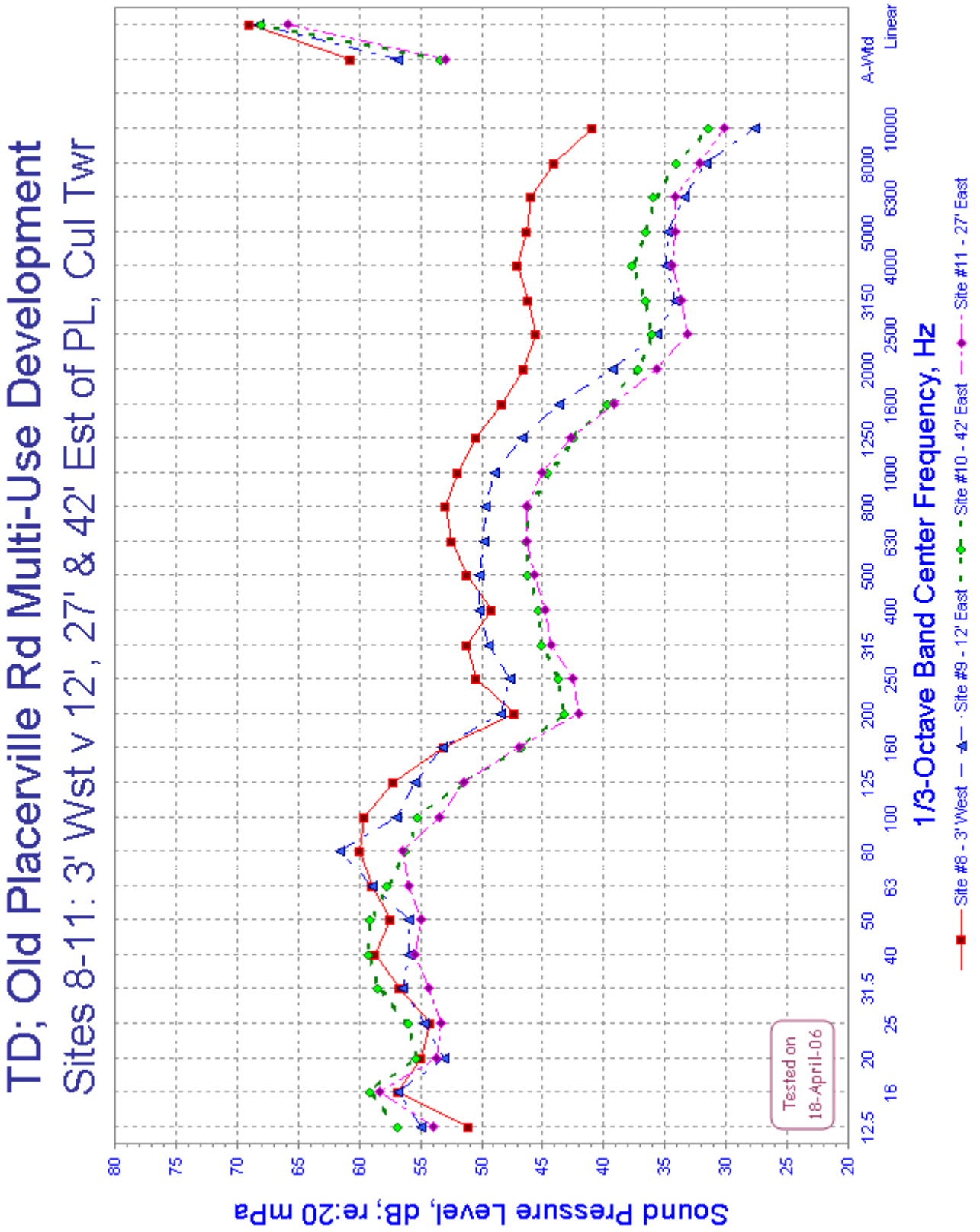

Figure 7. Tonal Content of Cooling Towers Measured at Supermarket Compared with Tests at Three Project Positions.