AN ABSTRACT OF THE THESIS OF

HARRY CROMWELL REEDER for the DEGREE OF MECHANICAL ENGINEER
(Name) (Degree)

in the DEPARTMENT OF MECHANICAL AND METALLURGICAL ENGINEERING
(Major department)

presented on 17 January 1973
(Date)

Title: ON DESIGN AND FIELD EVALUATION OF THE NOISE CONTROL FEATURES OF THE LAKE OSWEGO WATER TREATMENT PLANT

Redacted for Privacy

Abstract approved ______ Dr. James R. Welty

Concern about noise pollution has swept the country. People are conscious of their environment and are trying to preserve or to improve it. When the City of Lake Oswego selected a site for their water treatment plant, they had to assure the neighbors that it would not increase the ambient noise levels.

In order to meet this requirement, all of the sources within the plant had to be identified and evaluated. Results of indicated special treatment of the pump room were required to screen the pump noise from the neighborhood.

A baffle was designed and built to provide the required transmission loss. Data obtained after the plant was built showed that although the transmission loss was

less than estimated, the neighborhood ambient levels were unchanged after the water treatment plant was put into service.

ON DESIGN AND FIELD EVALUATION OF THE NOISE CONTROL FEATURES OF THE LAKE OSWEGO WATER TREATMENT PLANT

by

Harry Cromwell Reeder

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Mechanical Engineer

June 1973

APPROVED:

Redacted for Privacy

Professor of Mechanical Engineering in charge of major

Redacted for Privacy

Head of Department of Mechanical and Metallurgical Engineering

Redacted for Privacy

Dean of Graduate School

Date thesis is presented 17 January 1973

Typed by Susan Schroeder for Harry Cromwell Reeder

ACKNOWLEDGMENT

This manuscript is based on work done at Cornell, Howland, Hayes & Merryfield. Help was received from the Graphics and Secretarial departments. The author appreciates their support.

The assistance of Mr. Edward Daly and Dr. James Welty was valuable and is gratefully acknowledged.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ON DESIGN AND FIELD EVALUATION OF THE NOISE CONTROL FEATURES OF THE LAKE OSWEGO WATER TREATMENT PLANT

INTRODUCTION

In 1967 the City of Lake Oswego selected an optimum site when considering water system parameters for a new water treatment plant (WTP). The selected site was in a residential neighborhood, Figure 1, and the local people did not want a water processing plant as a neighbor, because of their concern for lights, additional traffic, and increased noise.

In regard to the increased noise, the City of Lake Oswego advised the residents that the existing ambient noise levels at their homes would not be increased with the addition of the treatment plant. The City then advised CH2M that, as designers of the water treatment plant, they must design the plant so that it made no contribution to the existing ambient noise levels.

CH2M then had to outline a program that would ensure this noise design constraint would be met. The program developed was as follows:

1. Make noise level surveys at the selected site to determine the existing ambient levels.

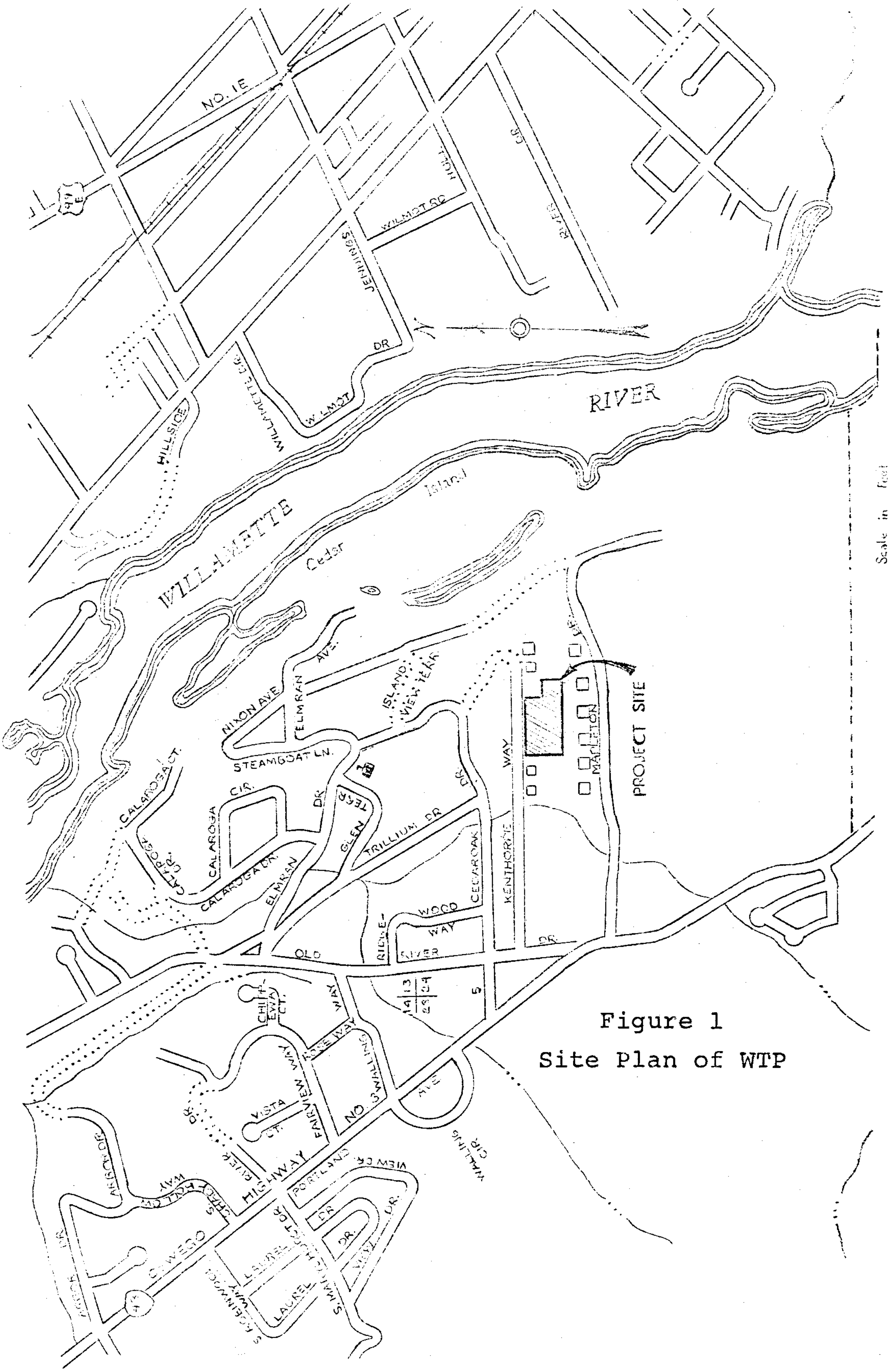


Figure 1
Site Plan of WTP

2. Identify all of the noise sources within the plant and estimate their noise levels if no data were available.

3. Based upon noise source and geometry of the plant, identify noise sources that would likely add to the existing ambient noise levels.

4. Design features into the water treatment plant that would prevent the plant noise level from adding to the existing ambient.

5. Measure the ambient noise levels after completion of the water treatment plant to verify that there had been no increase in ambient noise levels.

Briefly, the problem would be to design a water treatment plant that would not increase existing ambient noise levels.

Each discipline has a jargon of its own and there are terms that are unique to the acoustic discipline. Appendix A contains a list of definitions of the acoustical terms used in this report.

INSTRUMENTS AND DATA ACQUISITION

The instruments used during this project are owned by the Mechanical and Metallurgical Engineering Department of Oregon State University. All of the equipment used is manufactured by General Radio Co. As in definitions, the instrumentation used in acoustics is also unique.[4] A microphone is used to change the pressure fluctuations into an electrical signal. This electrical signal is then put through an amplifier and, if narrow band data is desired, a filtering network. Another procedure for obtaining and analyzing sound pressure level (SPL) is to record the microphone output on a high quality tape recorder and then play this recorded signal back through an analyzer that filters the signal and indicates SPL per one-third octave band.

A tape recorder was used to record existing ambient levels so that the data could be analyzed to obtain one-third octave band data. This was done to verify that there were no pure tone components present in the ambient noise.

After analysis, it was concluded that there were no narrow band components; therefore, only octave band data were obtained thereafter. It was judged that octave band data were sufficient to define the spectrums. The following instruments were used:

GR-1551-P1	Condenser Microphone System
GR-1307-A	Oscillator
GR-1552-B	Calibrator
GR-1551-C	Sound Level Meter
GR-1560-P5	Microphone
GR-1525-A	Tape Recorder
GR-1564-A	Sound and Vibration Analyzer
GR-1521-A	Graphic Recorder

Because people are annoyed by an intruding noise if it is audible, a time when people were most likely to be outdoors engaging in some quiet activity was selected for the survey. It was judged that this time was late afternoon and early evening on summer days when people would be enjoying an outdoor meal or just relaxing in their yards. Therefore, the initial survey was made between 5:00 and 9:00 p.m. Data were taken at several locations over the plant site.

After the plant was completed, only octave band data were taken at the nearest property line, near the building and inside the pump room.

DESIGN CRITERIA

Since the local residents were very vocal in their opposition to the plant, the City of Lake Oswego assured them that there would be no increase in the ambient noise levels. Therefore, the design levels were established by what existed prior to building the plant.

The ambient levels for design purposes were those that exist from 5:00 until 9:00 p.m., because these times represent the time periods when most family outdoor activities are performed, and when an intruding noise would be considered most annoying.

The ambient levels at the plant site were influenced mostly by two major arterials, 99E and the Oregon City-Lake Oswego Highway, which are in the vicinity, see Figure 1. Measurement of these levels was made on two different evenings at several locations around the plant site at various times. The test locations are shown as TS on Figure 2.

The existing ambient data were recorded on a tape recorder and then analyzed using a sound and vibration analyzer and a graphic recorder. Analysis of these data showed there were no narrow band components. Because there were none, octave band data were sufficient to describe the noise spectrum characteristics thereafter.

Data taken at the various locations indicated there were no appreciable spacial difference in noise levels. That is, the ambient noise level of the entire site could be considered homogeneous.

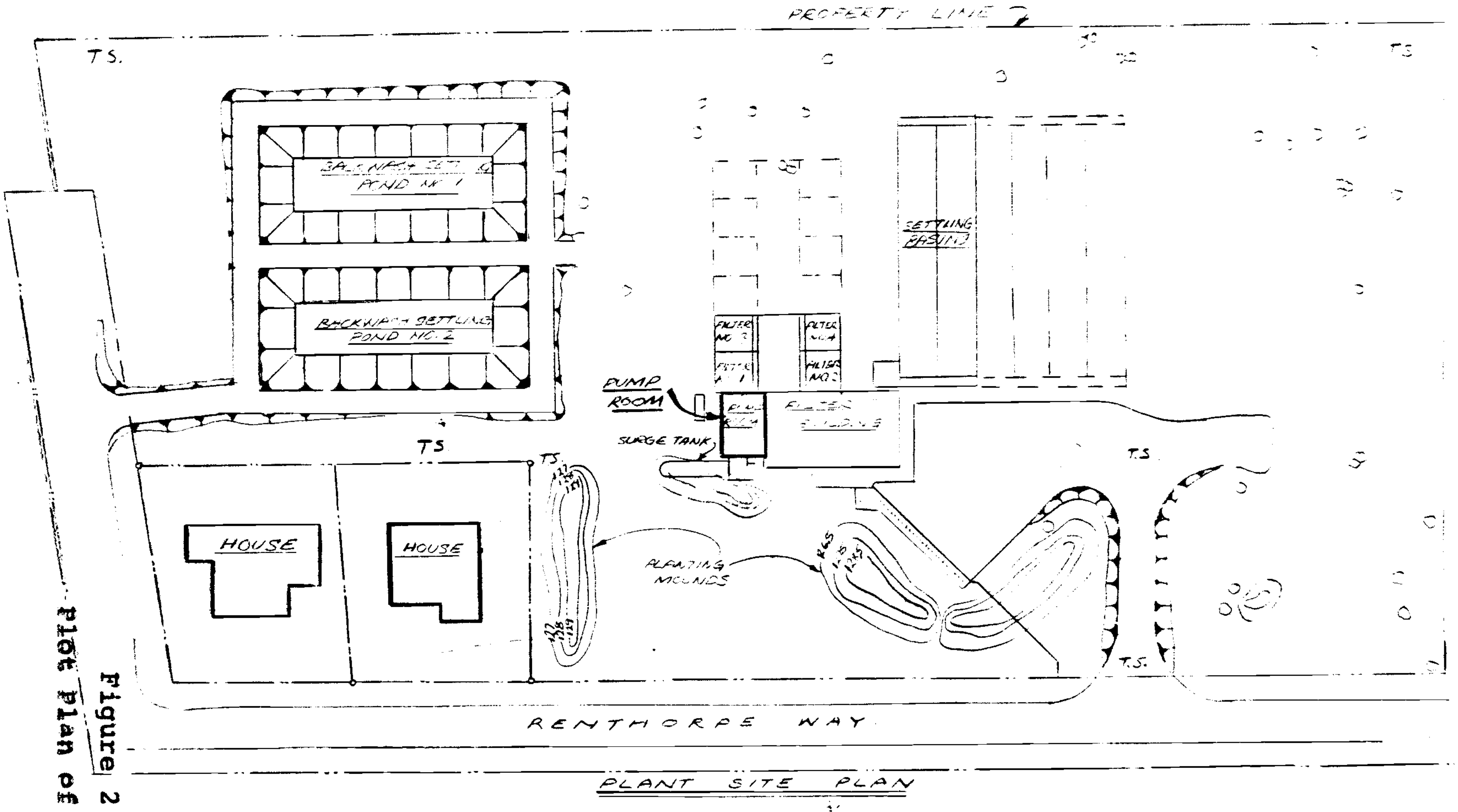


Figure 2
Plot Plan of WTP

Figure 3 shows the composite ambient noise level. Table 1, Appendix C, is a partial tabulation of the data from which Figure 3 originated. This composite spectrum was adopted as design criteria. The plant noise, when measured at the property line, was not to exceed these levels.

PLANT NOISE SOURCES AND EVALUATION

All of the major mechanical equipment within the proposed plant was listed. The noise levels of each and its location within the plant were evaluated to determine if this noise would add to the criteria established. Noise sources are as follows:

1. Roof mounted exhaust fans
2. Wall mounted exhaust fans
3. Air compressors
4. Chemical feed pumps
5. Chemical mixer
6. Distribution pumps
7. Backwash pump
8. Dry chemical feeders

There are four roof exhaust fans. Three are located over the pump room and one is located on top of the third floor. Manufacturer's data indicated that the three fans on the pump room roof were considered to be above the criteria, while the one on the third floor roof was below. The wall

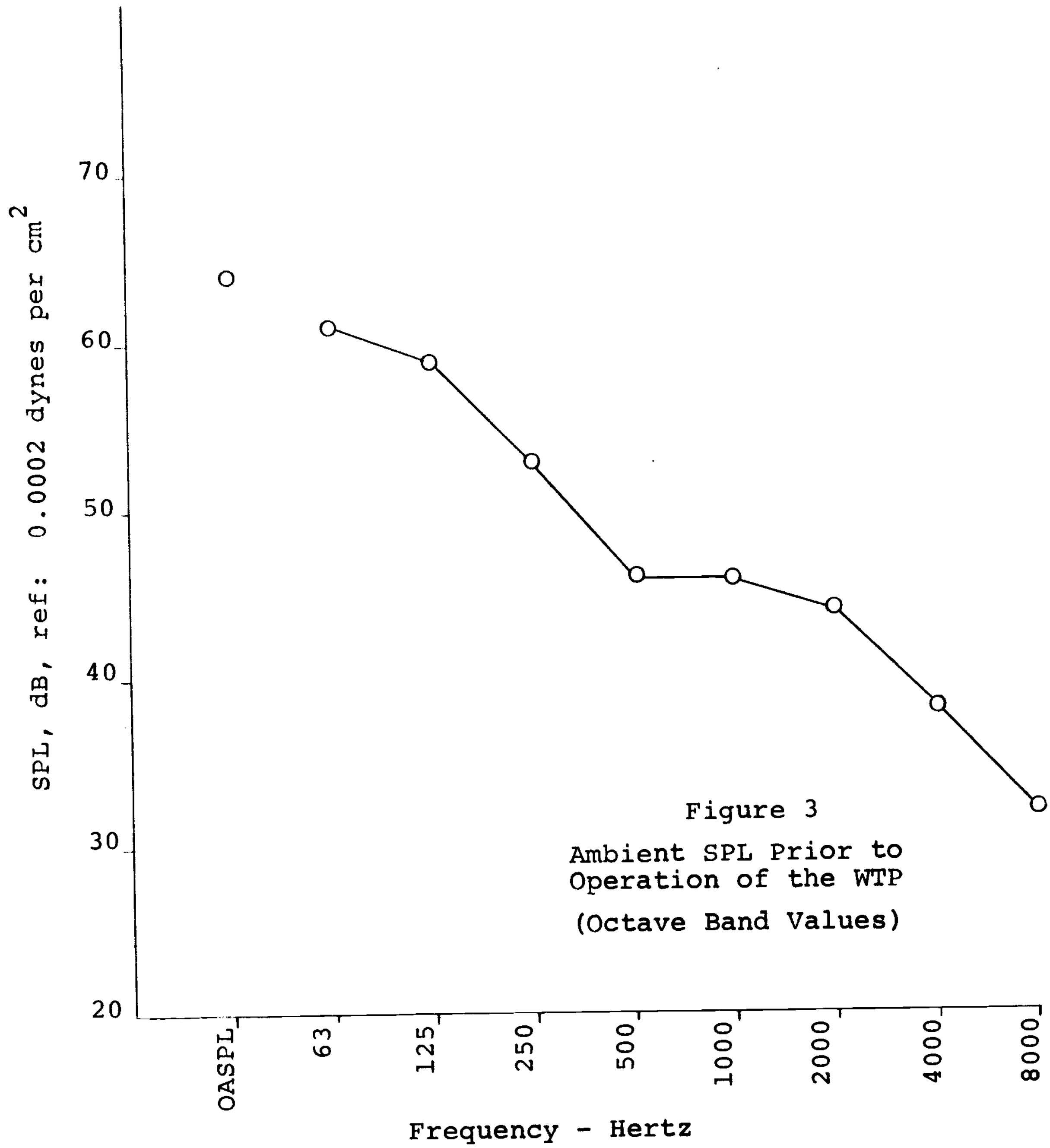


Figure 3

Ambient SPL Prior to Operation of the WTP

(Octave Band Values)

mounted exhaust fans, chemical feed pumps, chemical mixer, and dry chemical feeders were all found to be lower than the criteria based on manufacturer's or other data and were given no further consideration. The air compressors, although very noisy, were found to be no problem, because they were housed inside a room within the building. The ensuing transmission loss, 60 dB, incurred by having two walls between the source, air compressors, and the receiver, a person at property line, was sufficient to ensure no contribution from the air compressors.

The distribution pumps and backwash pumps are located in the pump room. Because of motor inefficiencies and the size of the pump motors, large amounts of heat are generated in the pump room.

To prevent excessive temperature in the pump room, one wall had three 5 by 5 foot louvers to provide an inlet for air that was subsequently exhausted by the three roof mounted exhaust fans. Because of the large opening in the wall, the effective transmission loss was diminished to the point where the pump room noise was estimated to be above design criteria.

We had now established all of the noise sources that would require special design techniques or equipment to meet the established criteria. These sources are as follows:

1. Three roof exhaust fans above pump room
2. Three distribution pumps

Note that the backwash pump was not a problem because its contribution to the noise in the pump room was not measurable when the distribution pumps were operating.

DESIGN FEATURES

The pump room roof exhaust fans were installed on special sound absorbing curbs supplied by the fan manufacturer. By using a combination of lower fan rotational speeds and the special curb, the fan noise according to manufacturer's data, was reduced to a level that would meet the design criteria.

The special curb had another benefit; that is, it reduced the pump noise propagating out of the exhaust fan opening.

This left only the pump noise to be blocked or attenuated to obtain the design goal of no additional noise to the neighborhood.

Prior to designing any feature, it was necessary to assess the problem in more detail. Since there was no noise data available from the pump manufacturer, it was estimated using methods established by Harris[5] and Bolt, Beranek, and Newman[2]. The estimated SPLs per octave band are shown on Figure 4 (note the spread in estimated levels). Rather than select one or the other spectrum, both were used. It was presumed that the pump spectrum would lie between these two estimated spectrums.

Before the pump spectrum can be used to determine the magnitude of the problem, it must be transformed into noise levels at the property line. To transform this spectrum to a property line level, the transmission loss (TL) of the wall was calculated.[1][3] First it was calculated with no openings in the wall. Then the TL was adjusted to account for the louver opening that amounted to approximately 20 percent of the wall.[2] After accounting for the wall TL, the levels were then reduced by 6 dB per doubling of distance (inverse square law). The results are shown on Figure 5, which includes both estimated spectrums, Harris, and Bolt, Beranek, and Newman, at the nearest property line.

To develop the amount of treatment required, these estimated levels were compared to the existing ambient level. The difference, Figure 6, is the amount of TL increase that must be obtained by special design.

There were three configurations considered. A screen inside the pump room in front of the louvers, a screen outside in front of the louvers, and extensive acoustical treatment within the pump room. The pump room was a very live room since all surfaces were concrete or concrete masonry units.

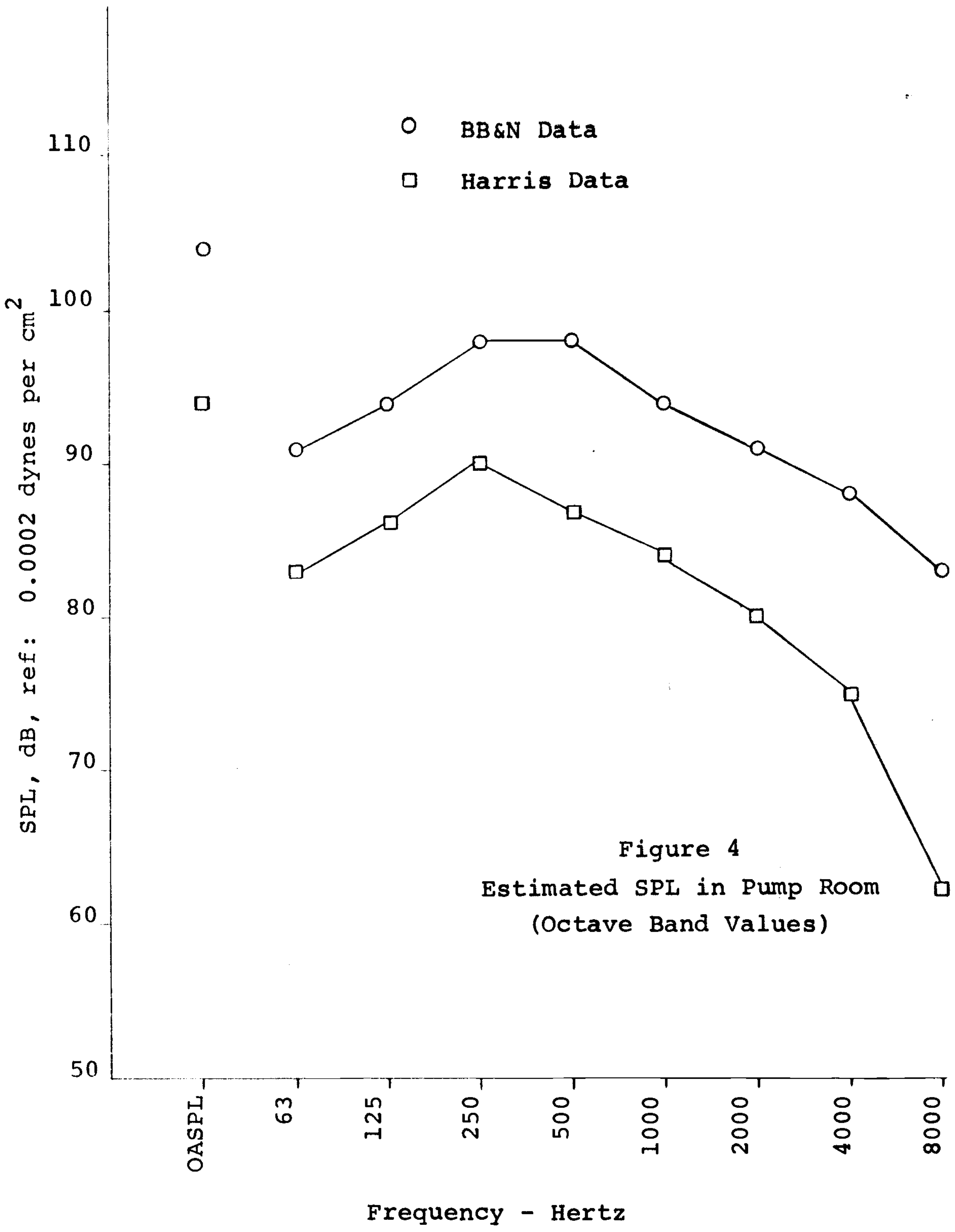


Figure 4
Estimated SPL in Pump Room
(Octave Band Values)

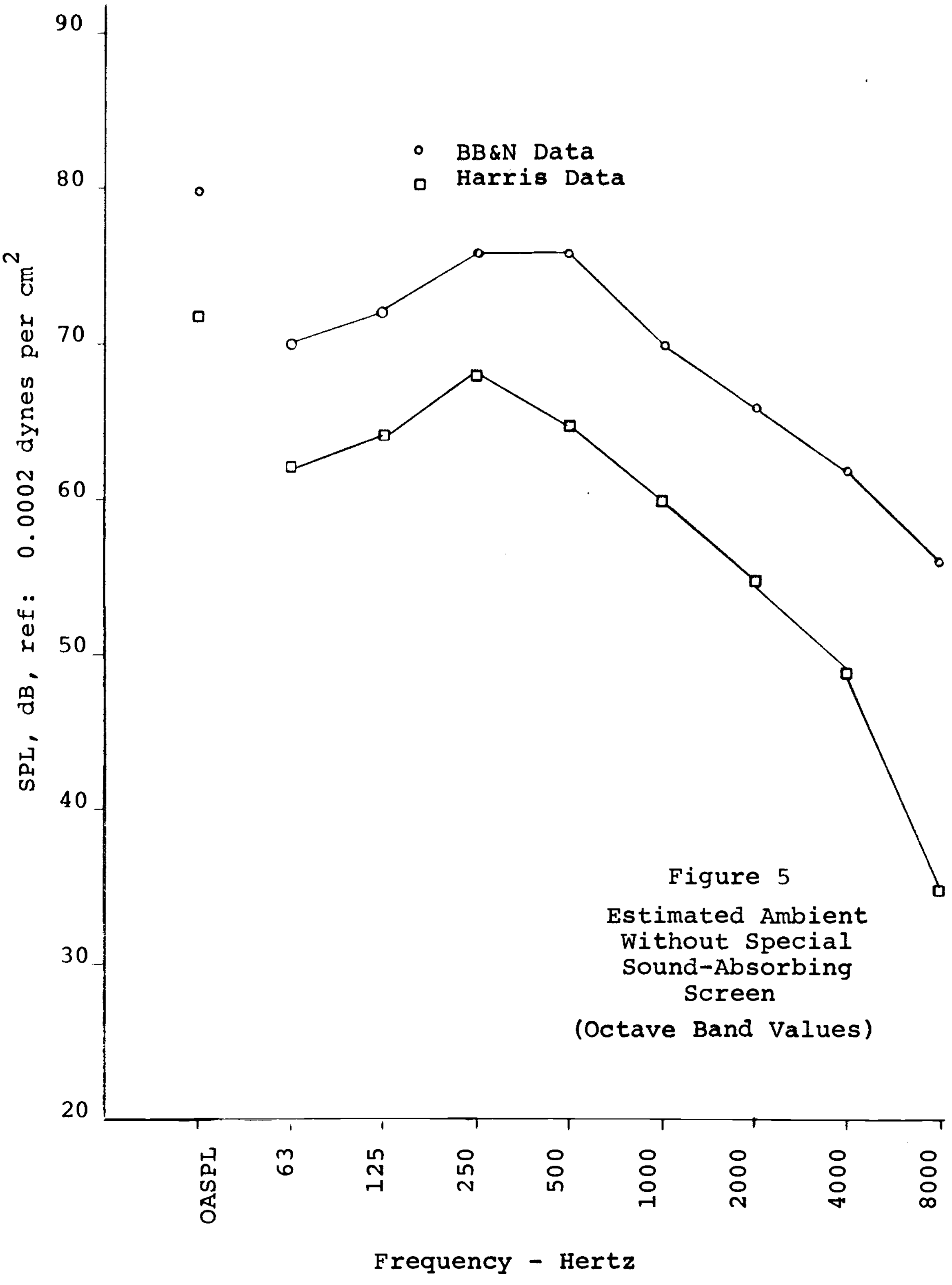


Figure 5

Estimated Ambient Without Special Sound-Absorbing Screen

(Octave Band Values)

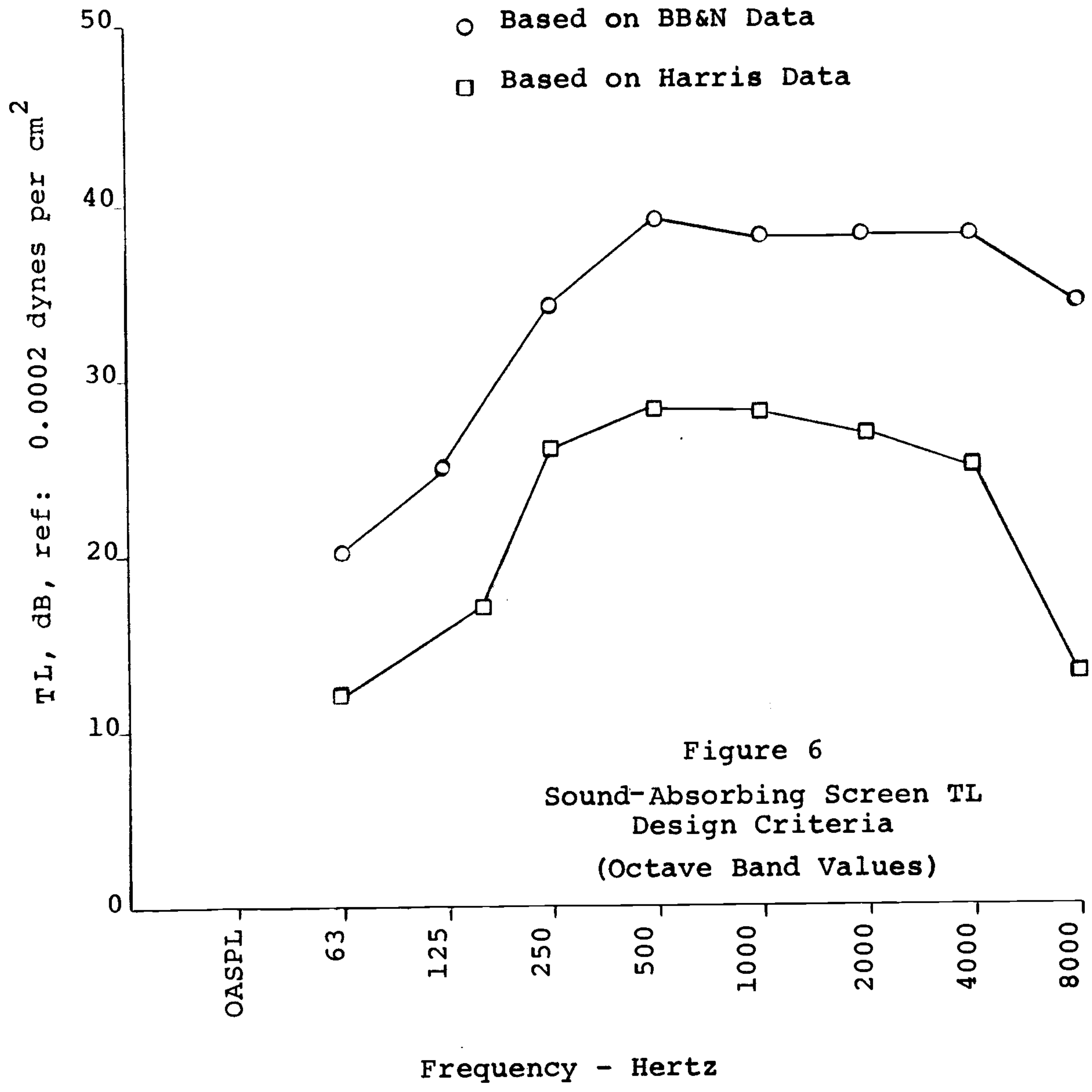


Figure 6

Sound-Absorbing Screen TL Design Criteria

(Octave Band Values)

The outside screen concept was rejected, because of a decrease in effectiveness when the screen was further away from the source and secondly, because of weather problems and aesthetics. The acoustical treatment to the room was rejected, because this approach would not provide the necessary attenuation. The inside screen was judged to be the best solution, because it blocked direct radiation of noise through the louver opening, provided acoustical treatment within the room, and provided a more effective barrier, because of its closeness to the source.

In addition to the acoustical considerations, there were other considerations that had to be evaluated. These non-acoustical properties were as follows:

1. Weight
2. Size
3. Maintainability
4. Mobility
5. Cost

Items 1, 2, and 4 are interdependent and establish the ability to move the screen. It was concluded that for plant operation, the screen's ability to be moved was important. Maintainability and cost were given less consideration, since there would be ample plant operating personnel to maintain the screen and since the total project costs were estimated to be one million dollars. This resulted in the cost of the screen affecting the total project cost very little.

There were two other influencing factors in the design:

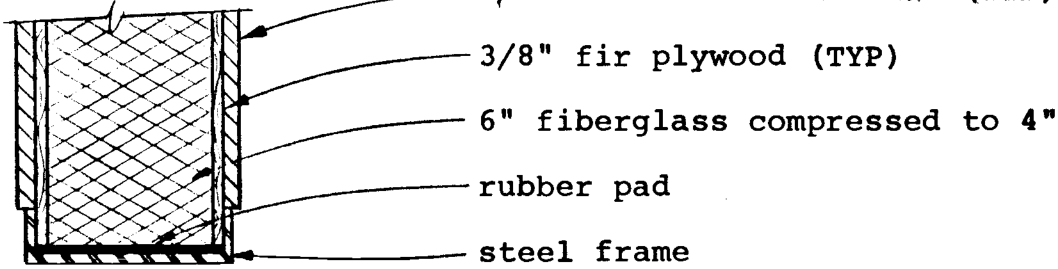
1. A desire to have the screen field fabricated by craftsmen who would be expected on the job site, and

2. The screen must not impede the airflow through the louvers.

Based on the acoustical and secondary considerations, a screen configuration consisting of plywood faced with sound absorbing material was selected, because these materials are familiar and readily available. The screen was designed to be bolted to the floor and ceiling and spaced away from the wall, so air could flow around all four sides.
Calculation of the screen TL showed that one thickness of plywood and sound absorbing material was not enough.
(The methodology of TL calculations and some sample calculations are shown in Appendix B.)

To increase the screen transmission loss, a two independent panel configuration was then selected. The two panels would be separate and thereby vibrate independently of each other, increasing their effectiveness. The calculation indicated a TL that would meet the acoustical criteria that had been established. The plywood panels were of equal thickness. This meant they both had the same critical frequency where they would not be as effective in blocking the noise. This critical frequency was approximately 800 Hertz where the adsorbing material was most effective; therefore it was not considered deleterious to the screen's effectiveness.

To improve the TL further, a fiberglass core was sandwiched between the two layers of plywood, see sketch below. Improvement occurs from two sources, first the mass of the barrier is increased thereby increasing the loss in the lower frequency range, second and more important, the fiberglass absorbs some accoustical energy as it passes through the core area both when it is a direct and reflected wave. The fiberglass is more effective in absorbing the higher frequencies.



The estimated transmission loss of the pump room wall with and without the addition of the screen are shown on Figure 7.

Another precaution was taken by the addition of acoustical material on the pump room wall. By adding this material, which had its maximum absorption coefficient in the same octave band as the estimated maximum pump noise, the room absorbed more acoustical energy. This deadened the room, thereby effectively increasing the transmission loss of the screen by making the pumps act as simple sources. With a live room, the entire room appears to be the source. Another benefit of the material on the wall was to reduce the noise going around the screen and repropagating from the louver opening. By having sound absorbing material on either side of the air passage between the screen and the wall that was louvered, the noise was attenuated by the material as it passed. This is similar to flow through a duct with sound absorbing walls.

RESULTS

After the treatment plant was built and placed into operation, data were obtained to verify the screen effectiveness and pump room noise level estimations. Representative data from these measurements is listed in Tables 2 and 3, Appendix C.

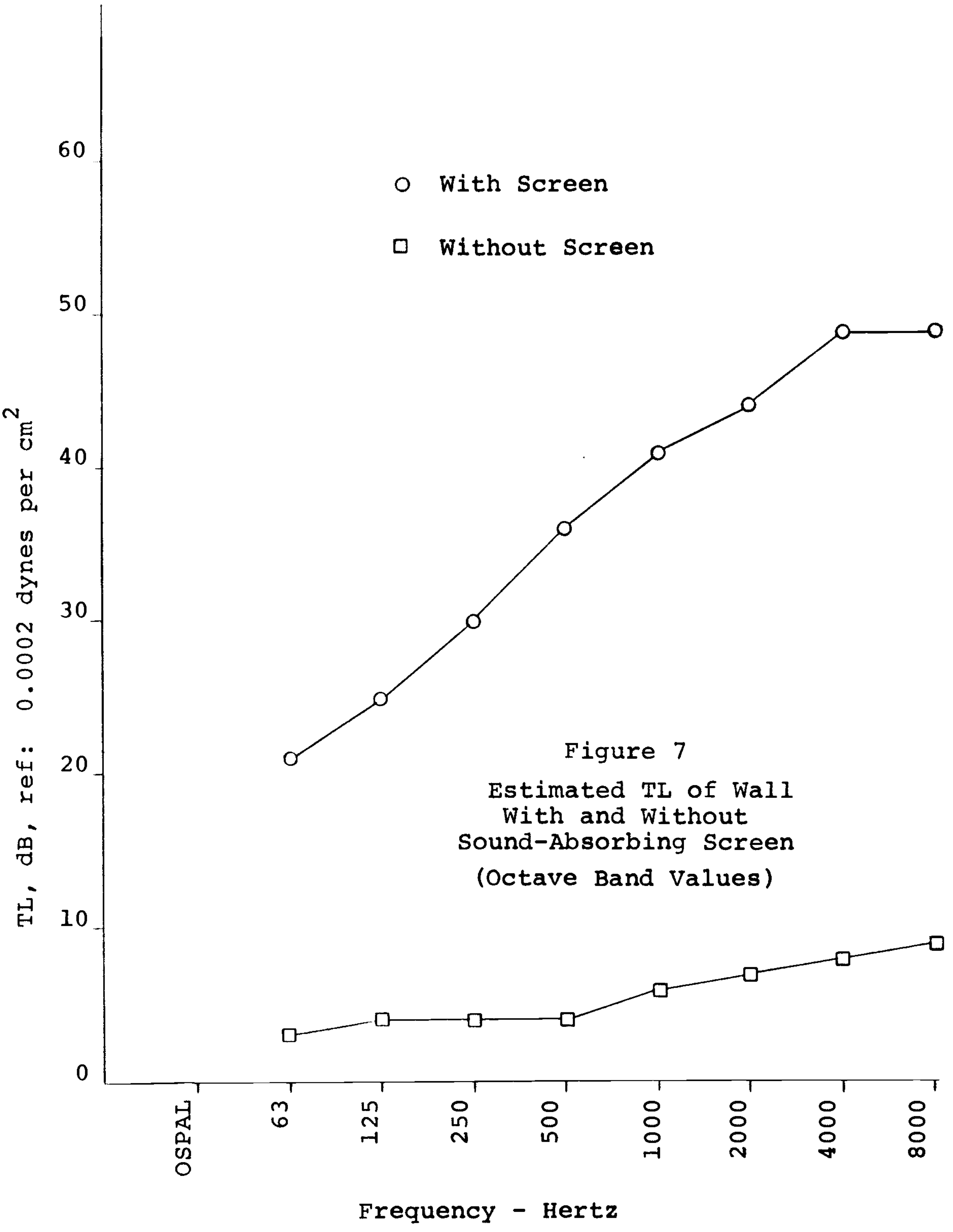


Figure 7

Estimated TL of Wall
With and Without
Sound-Absorbing Screen

(Octave Band Values)

Figure 8 shows the measured spectrum as it compares to the two spectrums that were estimated using methods previously discussed. As can be seen, the Harris SPL data was too low and the shape incorrect. The peak SPL was estimated to be at a lower frequency than the actual case. The Bolt, Beranek, and Newman data was too high and also had the peak level occurring two octaves too low. If an average of the two methods had been used, a much closer spectrum would have been predicted, Figure 9.

There were some advantages to the peak SPL occurring at a higher frequency than predicted; that is, the effectiveness of the sound absorbing material is greatest in the 500 to 2000 Hertz frequency range, therefore the transmission loss at these higher frequencies is improved. The peak at a higher frequency, although more annoying to operating personnel, was beneficial in meeting the criteria of no increase in ambient SPL.

From data taken outside the pump room, it was possible to establish the actual or effective transmission loss of the composite wall, that is, the wall plus screen combination. A comparison of these values is shown by Figure 10. The effective transmission loss was below that which was estimated, especially in the higher frequencies. This was contrary to what had been expected, since the screen's effectiveness at the higher frequencies should have been improved by the addition of the fiberglass in the core. There was no explanation

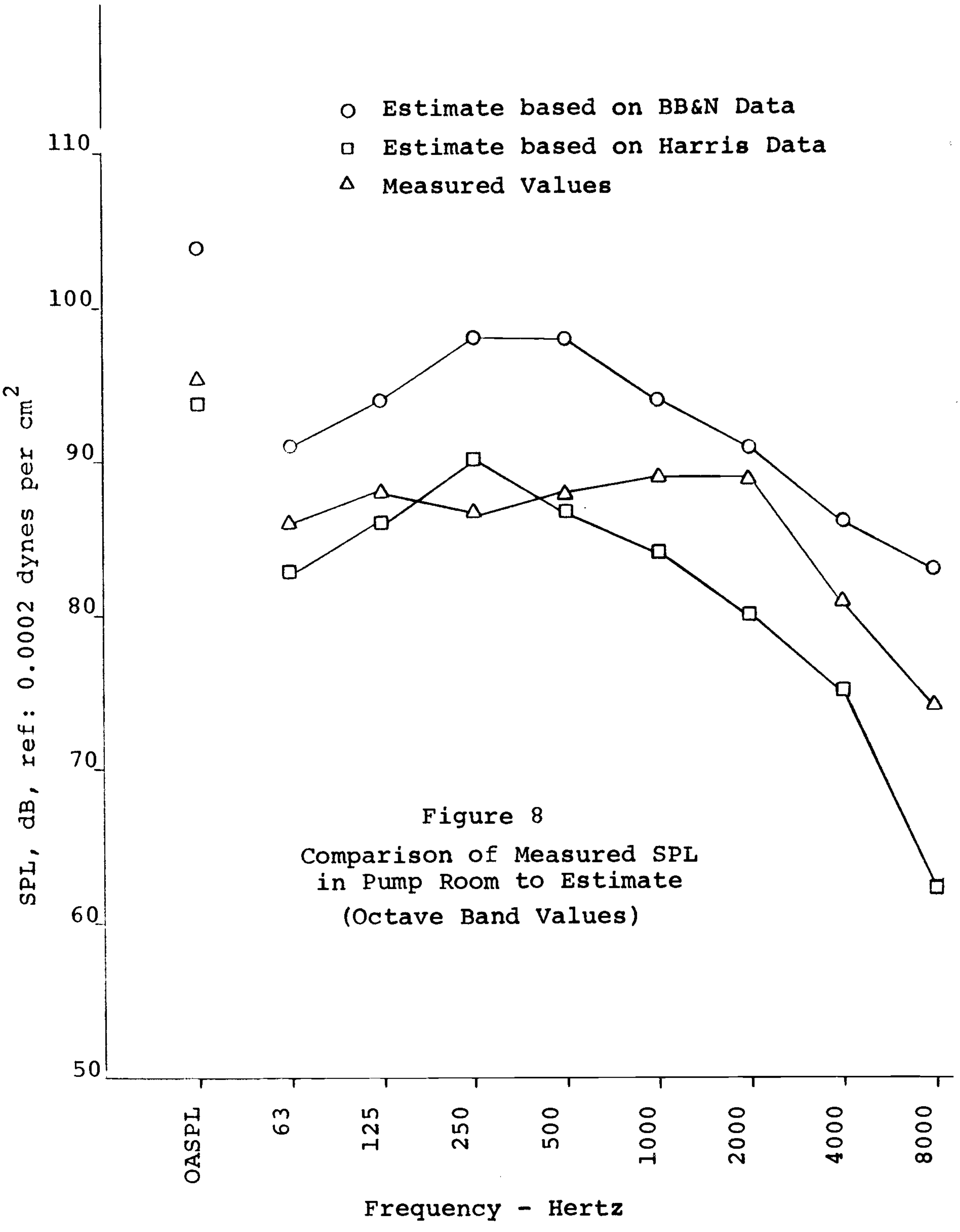


Figure 8

Comparison of Measured SPL in Pump Room to Estimate (Octave Band Values)

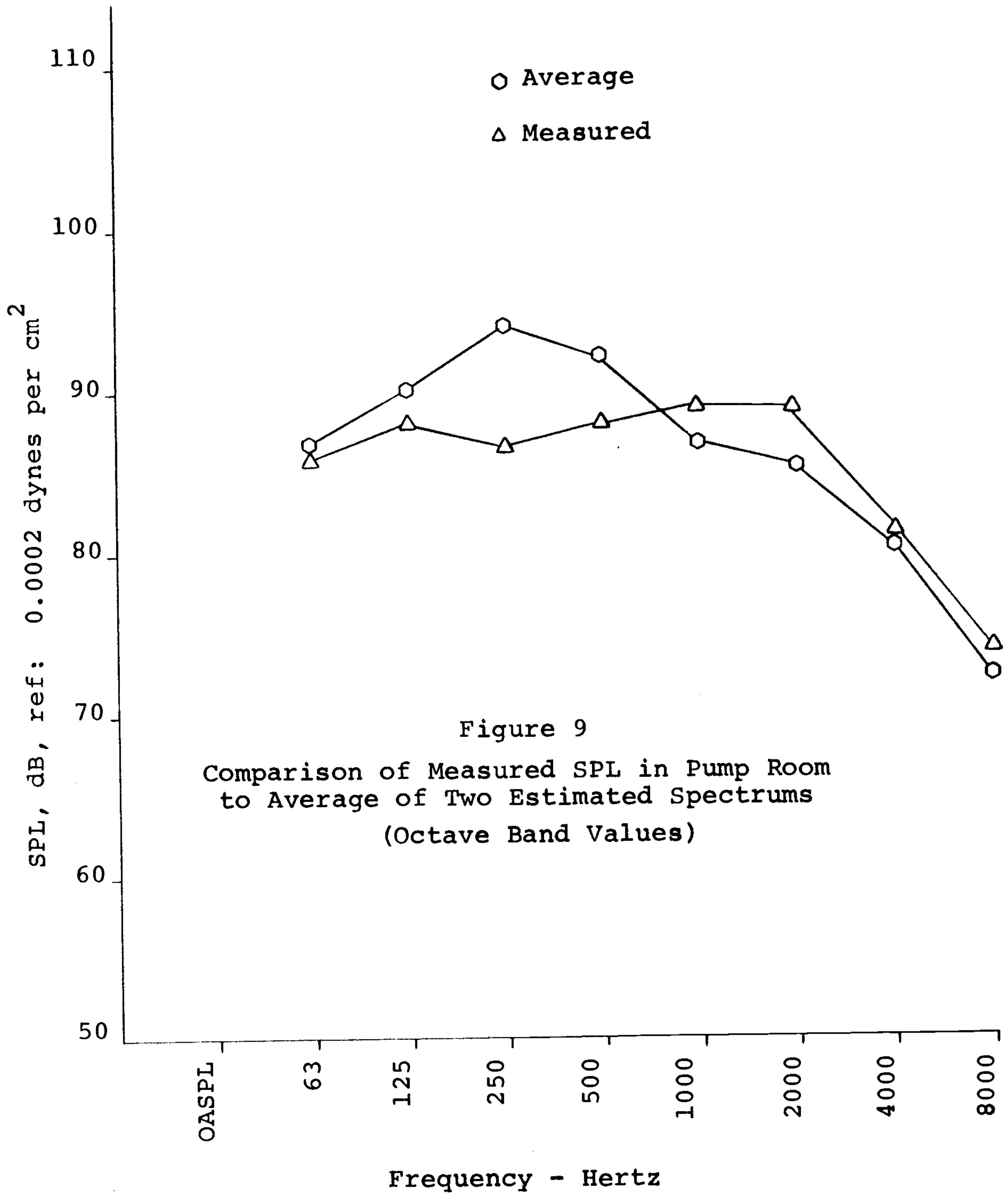


Figure 9

Comparison of Measured SPL in Pump Room to Average of Two Estimated Spectrums (Octave Band Values)

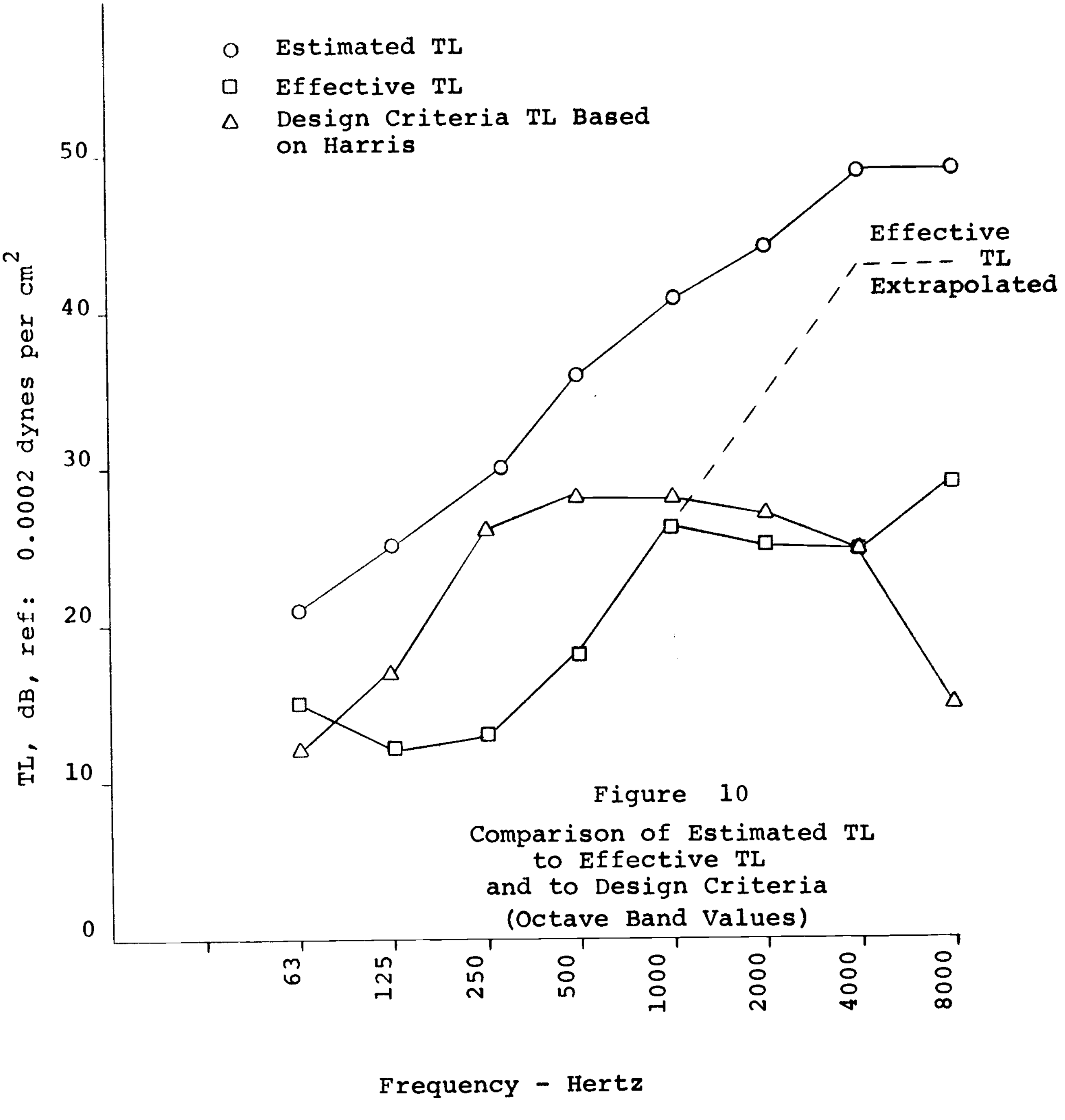


Figure 10

Comparison of Estimated TL to Effective TL and to Design Criteria (Octave Band Values) for this discrepancy.

However, the important comparison between effective and required transmission loss was favorable, as shown by Figure 10. The effective transmission loss was near or greater than those required except in the octave bands having center frequencies of 250 and 500 Hertz. But, this comparison is not the proof of the design; only by comparing ambient levels before and after the construction can the acoustical design be evaluated, because all of the other parameters were derived from estimates of one type or another.

Such a "before" and "after" comparison is made in Figure 11. As can be seen, the "after" exceeds the "before" spectrum by 1 or 2 dB in the lower frequencies and the "after" is less than the "before" in the higher frequencies. For a noise level to be significantly different than another, the the difference must be 3 dB or greater because most people cannot detect a 3 dB change in level when exposed to a random noise environment. It was concluded that the lower levels occur because of the time difference between the data gathering. The "before" data was obtained while there was a great deal of traffic on Highway 99E, which contributed heavily to the ambient at that time. The "after" data was taken just before noon, so that there would be a minimal amount of traffic. This time for data acquisition was selected, because the ambient level would be lower than

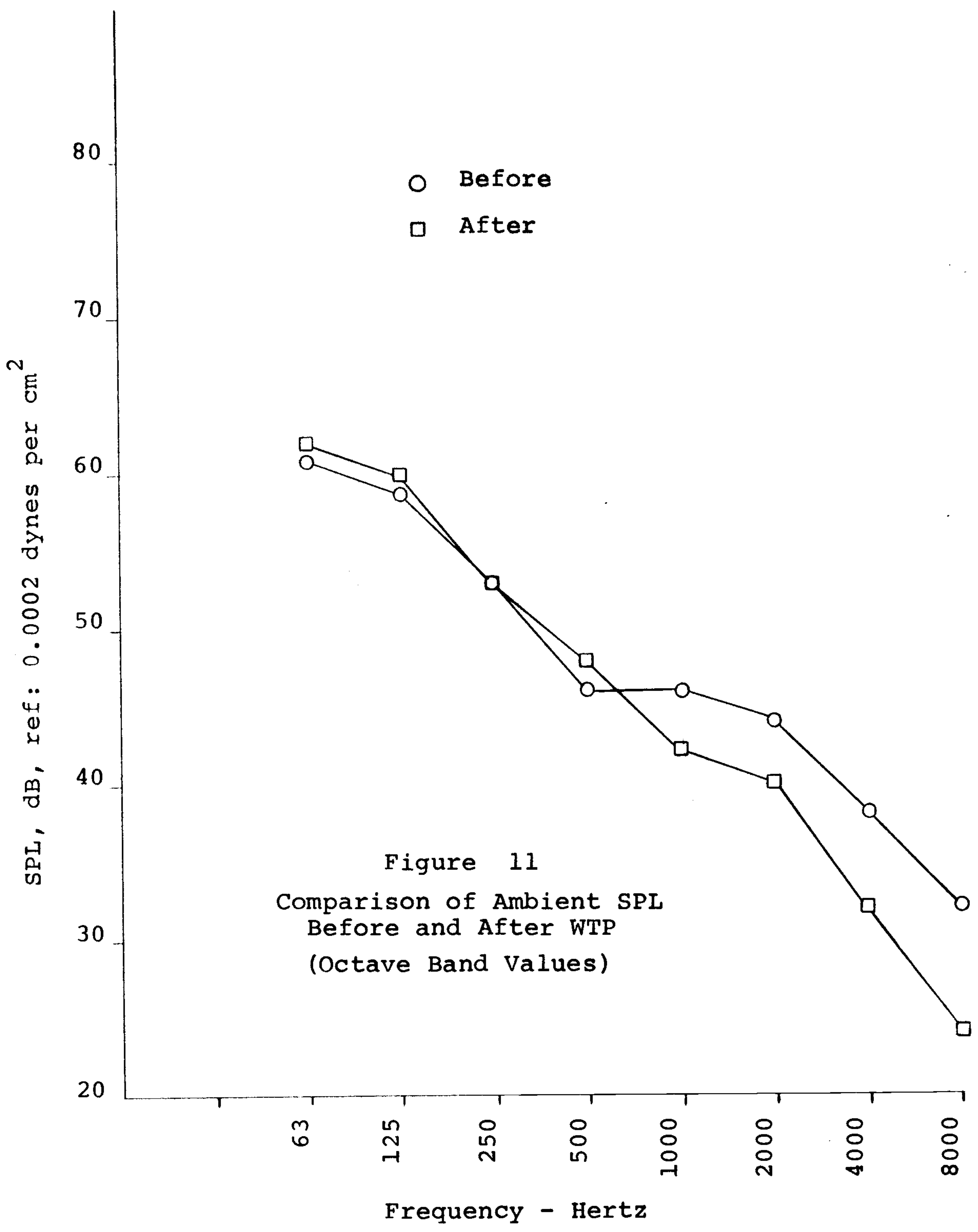


Figure 11

Comparison of Ambient SPL Before and After WTP

(Octave Band Values)

at 5:00 to 9:00 p.m., when traffic was heavier, and if the noise from the pumps could be heard, there would be less masking by the traffic sources.

As can be seen by Figure 11, the acoustically designed screen did achieve the result that the ambient noise level was not increased by the addition of the water treatment plant. The final acceptance of this was the fact that none of the neighbors complained. One did report that after dark when the children were inside and it was quiet, you could hear the pumps if you were very still and listened carefully.

BIBLIOGRAPHY

1. Beranek, Noise Control, McGraw-Hill Book Co., Inc. New York, New York, 1960, pages 361-415.

2. Bolt, Beranek, and Newman, Inc., Lecture Notes on "Noise and Vibration Control for Mechanical and Electrical Equipment in Buildings," Cambridge, Massachusetts, pages 3-24.

3. Callender, Time-Saver Standard, Fourth Edition, McGraw-Hill Book Co., Inc., New York, New York, 1966, pages 626-631.

4. General Radio Co., Handbook of Noise Measurement, General Radio Co., West Concord, Massachusetts, pages 124-151 and 221-232.

5. Harris, Handbook of Noise Control, McGraw-Hill Book Co., Inc., New York, New York, 1957, pages 30-33.

APPENDIXES

APPENDIX A
DEFINITIONS

Analyzer

An analyzer is a combination of a filter system and a system for indicating the relative energy that is passed through the filter system. The filter is usually adjustable so that the signal applied to the filter can be measured in terms of the relative energy passed through the filter as a function of the adjustment of the filter response vs. frequency characteristic. This measurement is usually interpreted as giving the distribution of energy of the applied signal as a function of frequency.

Decibel, dB

The decibel is one-tenth of a bel. Thus, the decibel is a unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power.

Note 1: Examples of quantities that qualify are power (any form), sound pressure squared, particle velocity squared, sound intensity, sound energy density, voltage squared. Thus the decibel is a unit of sound-pressure-squared level; it is common practice, however, to shorten this to sound pressure level because ordinarily no ambiguity results from so doing.

Note 2: The logarithm to the base the tenth root of 10 is the same as ten times the logarithm to the base 10: e.g., for a number x^2, $\log_{10^{0.1}} x^2 = 10 \log_{10} x^2 = 20 \log_{10} x$. This last relationship is the one ordinarily used to simplify the language in definitions of sound pressure level, etc.

Effective Sound Pressure

(Root-Mean-Square Sound Pressure)

The effective sound pressure at a point is the root-mean-square value of the instantaneous sound pressures, over a time interval at the point under consideration. In the case of periodic sound pressures, the interval must be an integral number of periods or an interval which is long compared to a period. In the case of non-periodic sound pressures, the interval should be long enough to make the value obtained essentially independent of small changes in the length of the interval.

Note: The term "effective sound pressure" is frequently shortened to "sound pressure."

Filter

A filter is a device for separating components of a signal on the basis of their frequency. It allows components in one or more frequency bands to pass relatively unattenuated, and it attenuates components in other frequency bands.

Frequency (in Cycles per Second or Hertz)

Frequency is the time of repetition of a periodic phenomenon. The frequency is the reciprocal of the period.

Level

In acoustics, the level of a quantity is the logarithm of the ratio of that quantity to a reference quantity of the same kind. The base of the logarithm, the reference quantity, and the kind of level must be specified.

Note 1: Examples of kinds of levels in common use are electric power level, sound-pressure-squared level, voltage-squared level.

Note 2: The level as here defined is measured in units of the logarithm of a reference ratio that is equal to the base of logarithms.

Note 3: In symbols

$$L = \log_r (q/q_o)$$

Where L = level of kind determined by the kind of quantity under consideration, measured in units of $\log_r r$

r = base of logarithms and the reference ratio

q = the quantity under consideration

q_o = reference quantity of the same kind

Note 4: Differences in the levels of two quantities q_1 and q_2 are described by the same formula because, by the rules of logarithms, the reference quantity is automatically divided out:

$$\log_r(q_1/q_o) - \log_r(q_2/q_o) = \log_r(q_1/q2)$$

Live Room

A live room is a room that is characterized by an unusually small amount of sound adsorption.

Microbar, Dyne per Square Centimeter

A microbar is a unit of pressure commonly used in acoustics. One microbar is equal to one dyne per square centimeter.

Note: The term "bar" properly denotes a pressure of 10^6 dynes per square centimeter, but this is no longer correct.

Microphone

A microphone is an electroacoustic transducer that responds to sound waves and delivers essentially equivalent electric waves.

Noise

(1) Noise is any undesired signal. By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in any transmission channel or device.

(2) Noise is an erratic, intermittent, or statistically random oscillation.

Note 1: If ambiguity exists as to the nature of the noise, a phrase such as "acoustic noise" or "electric noise" should be used.

Note 2: Since the above definitions are not mutually exclusive, it is usually necessary to depend upon context for the distinction.

Noise Level

(1) Noise level is the level of noise, the type of which must be indicated by further modifier or context.

Note: The physical quantity measured (e.g., voltage), the reference quantity, the instrument used, and the band width or other weighting characteristic must be indicated.

(2) For airborne sound, unless specified to the contrary, noise level is the weighted sound pressure level called sound level; the weighting must be indicated.

Octave

(1) An octave is the interval between two sounds having a basic frequency ratio of two.

(2) An octave is the pitch interval between two tones such that one tone may be regarded as duplicating the basic musical import of the other tone at the nearest possible higher pitch.

Note 1: The interval, in octaves, between any two frequencies is the logarithm to the base 2 (or 3.322 times the logarithm to the base 10) of the frequency ratio.

Note 2: The frequency ratio corresponding to an octave pitch interval is approximately, but not always exactly, 2:1.

Simple Sound Source

A simple sound source is a source that radiates sound uniformly in all directions under free-field conditions.

Sound Level

Sound level is a weighted sound pressure level obtained by the use of metering characteristics and the weighting specified in the American Standard Sound Level Meters for Measurement of Noise and Other Sounds, Z24.3-1944, or the latest approved revision thereof. The weighting employed must always be stated. The reference pressure is 0.0002 microbar.

Note: A suitable method of stating the weighting is, for example, "The A sound level was 43 dB."

Spectrum

(1) The spectrum of a function of time is a description of its resolution into components, each of different frequency and (usually) different amplitude and phase.

(2) "Spectrum" is also used to signify a continuous range of components, usually wide in extent, within which waves have some specified common characteristic; e.g.,

"audio-frequency spectrum." The term spectrum is also applied to functions of variables other than time, such as distance.

Transmission Loss

Transmission loss is the fraction of sound energy in the incident airborne wave that does not appear in the transmitted airborne wave on the opposite side of the wall.

APPENDIX B

TRANSMISSION LOSS METHODOLOGY AND SAMPLE CALCULATIONS

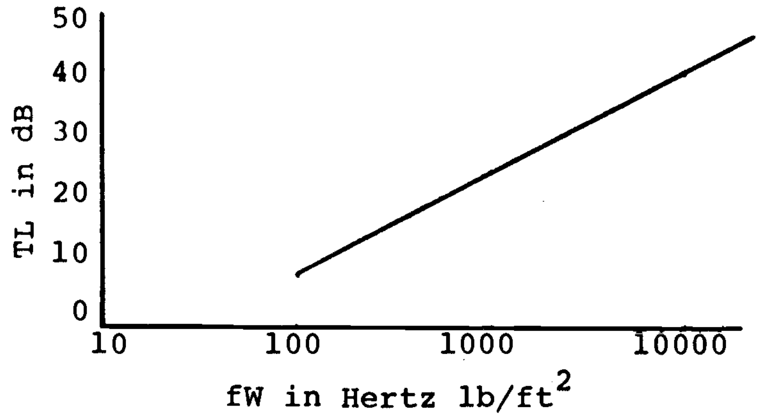
I. Methodology for estimating TL of screen

A. Select a sheet of log (semi-log) paper and label the abscissa log scale frequency in Hertz. Start with 125 Hertz and label the rest of the marks with the octave band center frequencies. Label the ordinate TL in dB.

B. From the data below and screen thickness, determine the surface weight of the panel.

Material	Specific Surface Density - lb/ft inch of thickness	Plateau Height dB	Plateau Width Octaves
Aluminum	14	29	3.7
Dense Concrete	12	38	3.3
Glass	13	27	3.3
Lead	59	56	2.3
Sand Plaster	9	30	3.0
Fir Plywood	3	19	2.7
Steel	40	40	3.7
Brick	11	37	3.3

C. From the below field incidence curve, select the TL of the panel from some arbitrary selected frequency times surface weight. Plot this value of graph (Item A) and draw a line with a 6 dB per octave slope through it.



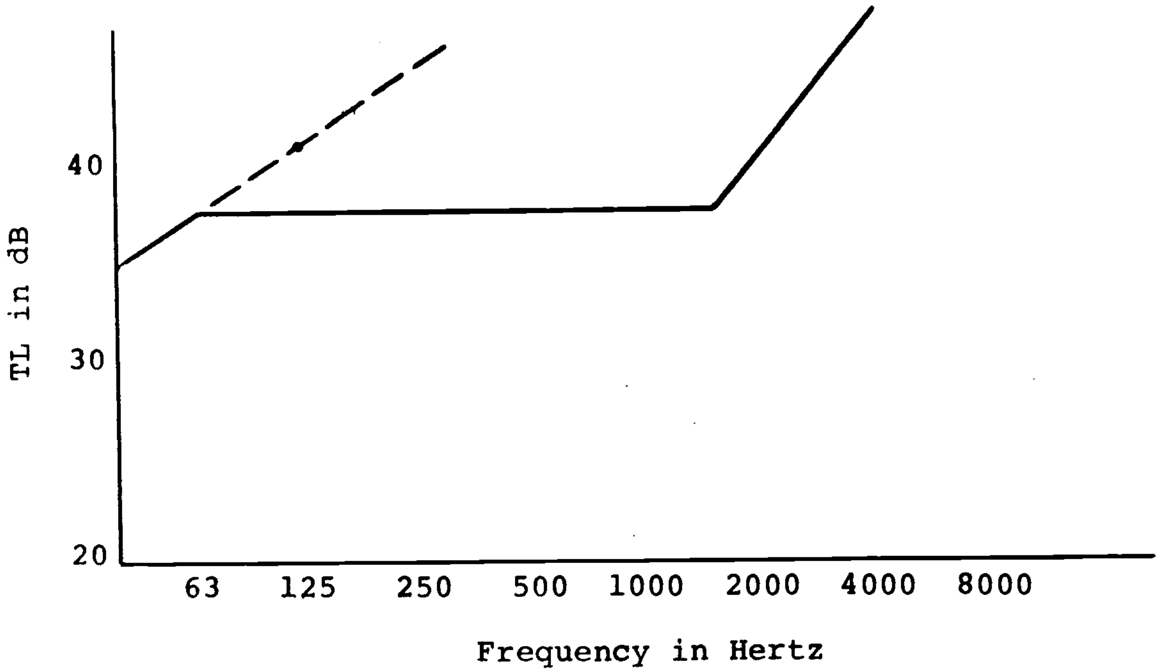
D. Determine plateau height from table listed under Item B. Draw a horizontal line through it so that the line intersects the field incidence line (Item C).

E. Determine the plateau width from table listed under Item B. This determines the width, in octave bands, of the plateau from the intersection of field incidence and plateau height to its end at the higher frequency.

F. At the high frequency end of the plateau, draw a line that slopes at 10 dB per octave.

II. Sample Calculation

Find TL loss of 8" thick concrete wall



Item B - 8" x 12 lb/ft^2 - in = 96 lb/ft^2

96 lb/ft^2 x 125 Hz = 12,000 Hz lb/ft^2

Item C - From C TL = 45

Item D - Plateau height = 38

Item E - Plateau width = 3.3 octaves

Item F - Shown on sketch

APPENDIX C

TABULATION OF REPRESENTATIVE DATA

TABLE NO. 1

AMBIENT LEVELS PRIOR TO

WATER TREATMENT PLANT

By: Harry Reeder

Date: 24 and 25 September 1969

Location: 4260 Kenthrope Way, West Linn

Run No.	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
1	58	60	60	49	40	43	43	40	34
2	60	62	55	48	39	41	40	44	46
3	50	52	38	38	38	39	43	37	28
4	52	56	57	50	40	39	37	37	33
5	56	61	56	57	48	44	38	36	32
6	59	62	65	55	50	50	50	49	49
7	59	61	60	56	50	50	48	41	33
8	59	65	62	55	50	54	49	38	32
9	56	60	58	53	46	56	48	36	29

TABLE NO. 2

NOISE LEVEL IN PUMP ROOM

By: Harry Reeder

Date: 30 October 1969

Location: Pump Room

Position	A Scale	Lin. Scale	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
5' from screen	90	92	73	82	80	79	82	83	85	75	68
under screen	89	91	75	84	87	82	82	82	82	74	66

TABLE NO. 3

AMBIENT LEVELS AFTER

WATER TREATMENT PLANT

By: Harry Reeder

Date: 30 October 1969

Location: Outside Pump Room

Position	A Scale	Lin. Scale	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
5' from building wall	65	75	61	65	69	68	65	57	58	49	39
at property line	60	65	56	62	60	53	48	42	40	32	24