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Volume IV

ENVIRONMENTAL BASELINE MONITORING IN THE AREA OF GENERAL CRUDE OIL-- DEPARTMENT OF ENERGY PLEASANT BAYOU NUMBER 1-- A GEOPRESSURED-GEOTHERMAL TEST WELL--1978

MASTER

by

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APPENDIX III:
NOISE SURVEY
RADIAN CORPORATION
AUSTIN, TEXAS

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Evaluation of Community Noise Impacts from a Geothermal-Geopressure Drilling Operation

7 November 1978

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1.0 INTRODUCTION

This section discusses assessment techniques and results of noise as related to operation of the well drilling system.

1.1 Overview

This report presents results of a study to determine the acoustical noise distribution and impacts of the geothermal/geopressure well drilling operation near Chocolate Bayou in South Texas.

Detailed noise survey data were included as part of the study for computer simulations to develop representative and worst-case drilling operation noise predictions. Also conducted were baseline noise measurements throughout the Peterson Landing residential area. This inhabited area was of primary concern due to its close proximity to the geothermal well site.

1.2 Objectives and Techniques

The primary study objective was to assess the environmental noise impact due to a well drilling facility near the South Texas community of Peterson Landing on the Chocolate Bayou. To perform this assessment, a systematic data acquisition and analysis process was necessary. The various assessment steps included the following:

- perform field measurement survey of all areas that may be affected by the proposed project.

- acquire available acoustical data pertinent for characterizing (and corroborating measured data) the sound fields in potentially affected areas

- process data and describe the noise character of the study area

- acquire acoustical data on operational equipment (complete drilling rig system) associated with the project

- exercise Radian's Environmental Noise Prediction Model (ENPM) to describe sound fields from these sources

- establish evaluation criteria against which to measure noise impacts

- assess impact of noise by imposing forecast noise fields upon established ambient conditions

- recommend mitigating measures if required and re-run the ENPM if necessary to determine degree of acoustical noise abatement if required

- perform an operational period noise survey throughout concerned areas

1.3 Summary of Results

To accurately forecast potential noise impacts, it was necessary to obtain a description of the radiated noise at

pre-selected distances from the drilling operation in terms of octave band sound pressure level and directivity. These data were unavailable from the drilling rig manufacturer making it necessary to perform source measurements on a drilling rig of similar characteristics.

It had initially been anticipated that a 2100 HP drilling system was to be used at the Chocolate Bayou well site. Such a system was located operating near Hallettsville, Texas in an environment which duplicated the Chocolate Bayou location ideally. Sound pressure levels and directivity data were measured and used as input data in Radian's Environmental Noise Prediction Model (ENPM). Thus, the retrieved data from the Hallettsville operation served as a reference noise source in order to predict the Chocolate Bayou drilling operation noise impacts.

Analysis of the existing sound field throughout the Peterson Landing area revealed a dominant influence from noise radiated by the Monsanto Chemical facilities located across the Chocolate Bayou. Overlaying the ENPM (L_{dn}) results onto the concerned residential baseline data graphically displayed that with proper drilling rig orientation no additional noise (L_{dn}) to the Peterson Landing area would be created. The Hallettsville data did indicate obvious directivity characteristics, making system orientation a critical consideration for the Chocolate Bayou installation.

Once drilling had begun, a complete noise survey was again performed throughout the concerned area. A map of the concerned area was perpared showing sound level isopleths in terms of L_{dn} with the drilling system in full operation. The final survey data demonstrated (as predicted) no perceptible noise was added to the Peterson Landing residential area due to the drilling operation.

2.0 BASELINE AND SOURCE MEASUREMENTS

This section contains the results of the drilling system noise predictions and concerned area baseline noise surveys.

2.1 Drilling Rig Source Data

To predict the expected acoustical strength and radiation patterns from the drilling rig system (generators, pumps, electric and diesel engines) the acoustical character of the complete system must be known. This includes knowing the strength of radiated levels in terms of direction and distance from the source under various operational modes.

Initially, a 2100 HP drilling system was to be used for the Chocolate Bayou project. Radiated noise information in terms of octave band sound pressure level and directivity was unavailable from the manufacturer. It was therefore necessary to obtain these data from a similar system operating in a similar environment. Such a drilling system was located operating near Hallettsville, Texas.

On January 17, 1978 sound pressure levels were measured at Hallettsville. The drilling system was generally representative of the system to be used at the Chocolate Bayou geothermal well site.

Complete octave band data and dBA levels were measured in four vectors at distances of 100, 300, 600, and 900 feet from the drilling rig perimeter. The results are plotted in Figures 1, 2, 3, and 4. These source data were used for input into the Environmental Noise Prediction Model (ENPM) and used as a factor in orienting the drilling facility at the Peterson Landing site.

ACOUSTIC NOISE DATA SHEET

NOISE SOURCE #1 ETZLER, HALLETSVILLE, TEXAS DATE/TIME 1/17/78 (1200-1400)

WIND SPEED AND DIRECTION NW-6TO10MPH RELATIVE HUMIDITY 90-100

OPERATOR MLW/DWB

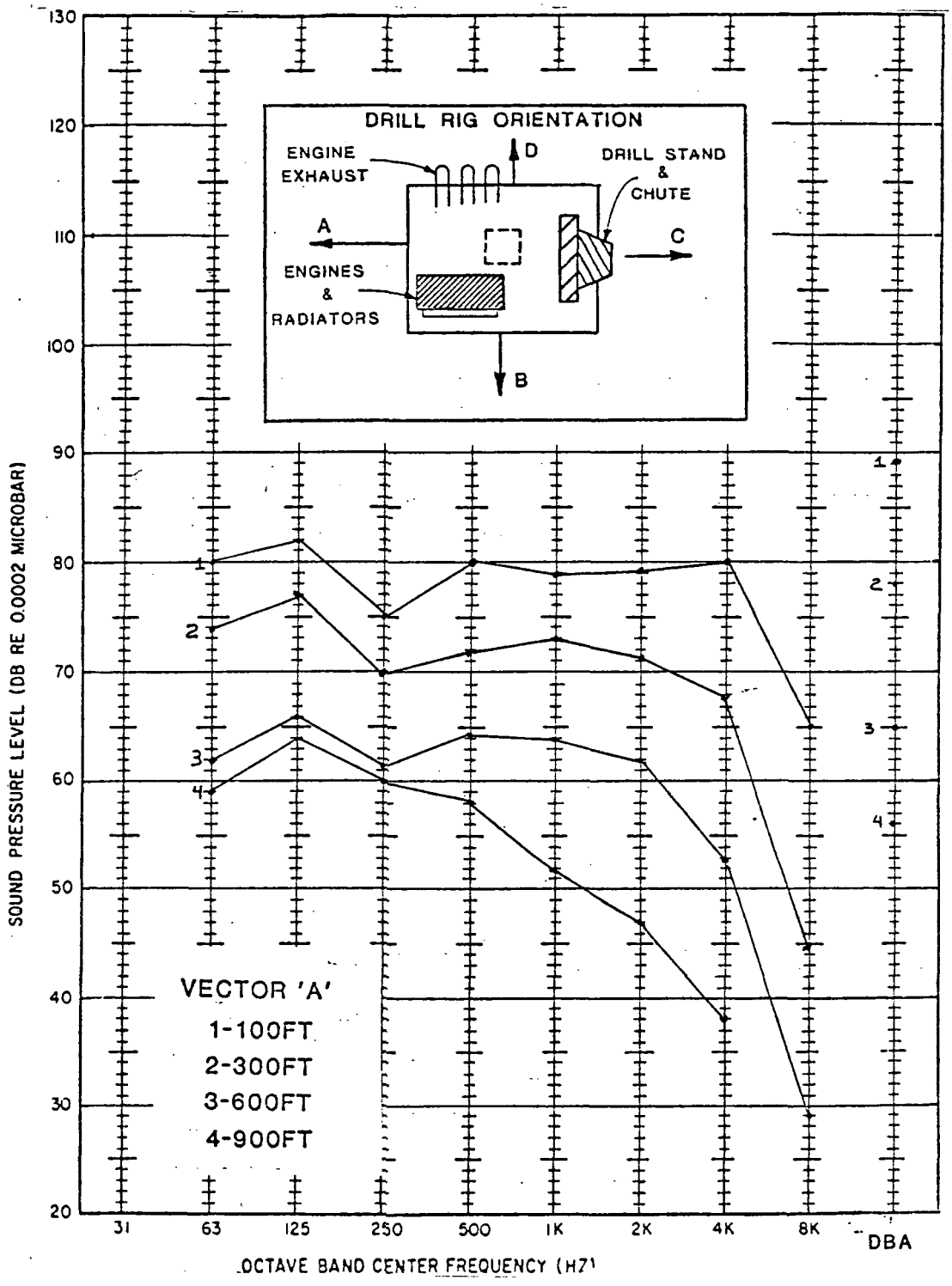


FIGURE 1. MEASURED "A" WEIGHTED AND OCTAVE BAND CENTER FREQUENCY SOUND PRESSURE LEVELS

ACOUSTIC NOISE DATA SHEET

NOISE SOURCE #1 ETZLER, HALLETSVILLE, TEXAS DATE/TIME 1/17/78 (1200-1400)

WIND SPEED AND DIRECTION NW-6TO10MPH RELATIVE HUMIDITY 90-100

OPERATOR MLW/DWB

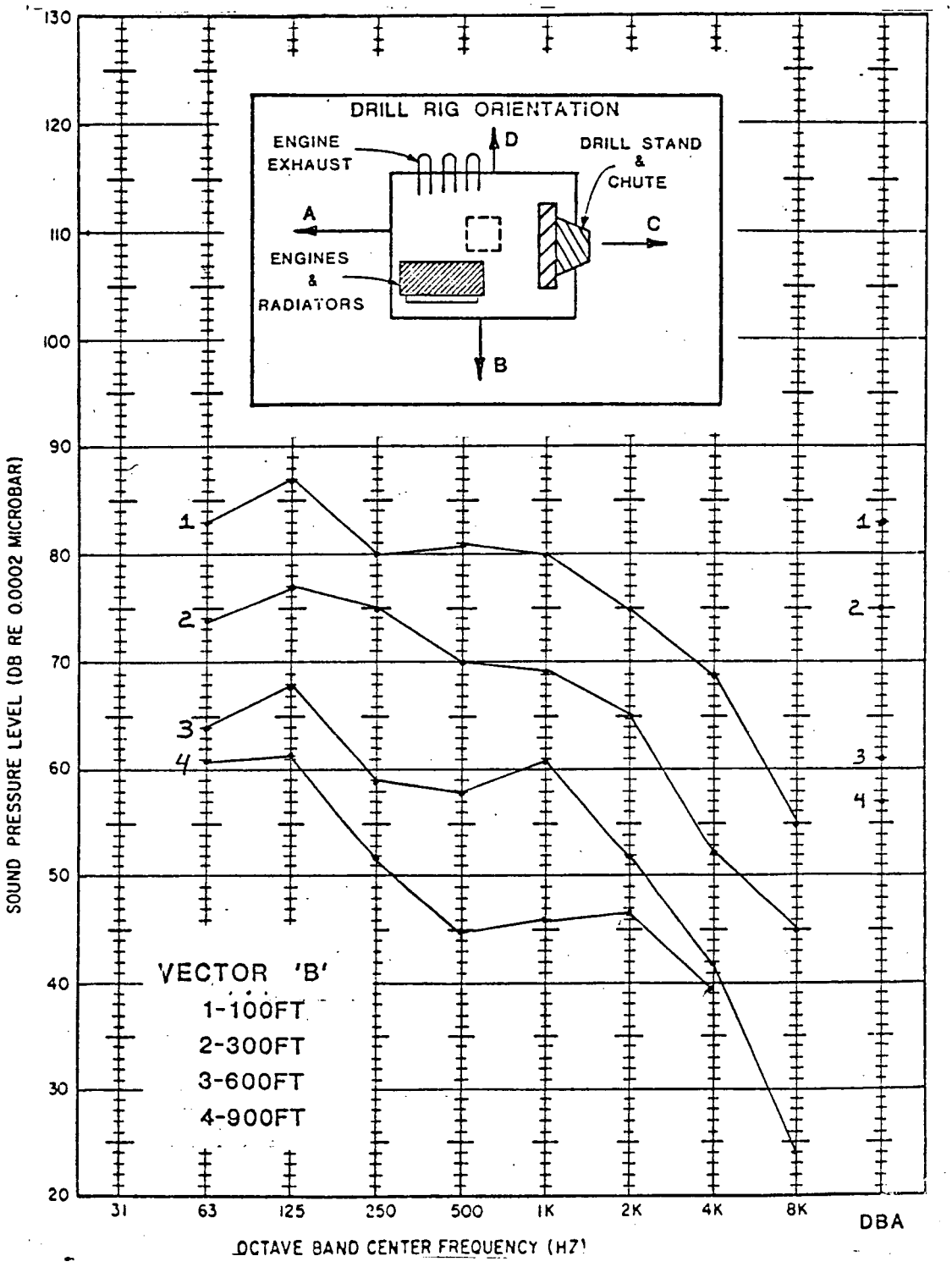


FIGURE 2. MEASURED "A" WEIGHTED AND OCTAVE BAND CENTER FREQUENCY SOUND PRESSURE LEVELS

ACOUSTIC NOISE DATA SHEET

NOISE SOURCE #1 ETZLER, HALLETSVILLE, TEXAS DATE/TIME 1/17/78 (1200-1400)

WIND SPEED AND DIRECTION NW-6TO10MPH RELATIVE HUMIDITY 90-100

OPERATOR MLW/DWB

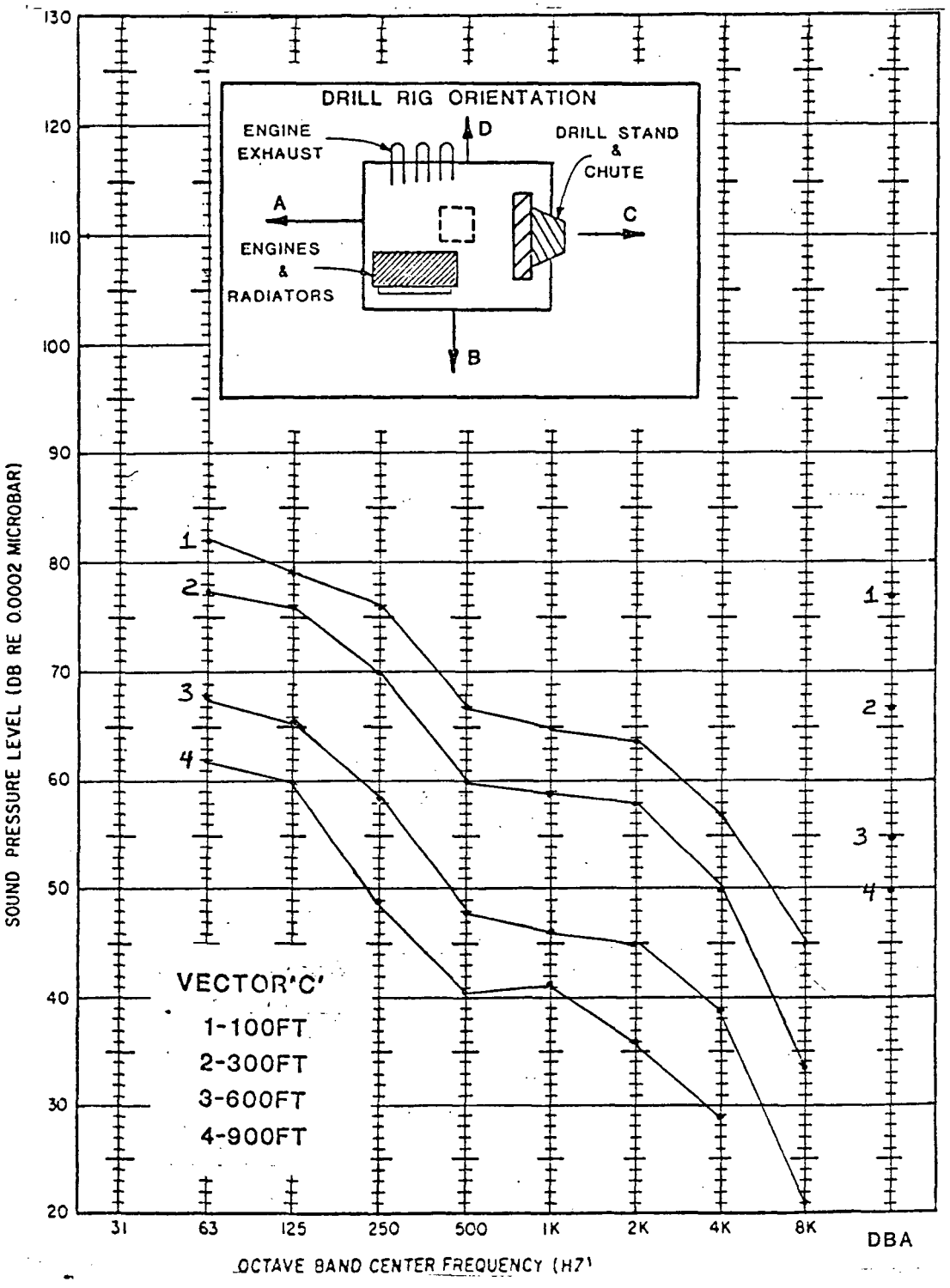


FIGURE 3. MEASURED "A" WEIGHTED AND OCTAVE BAND CENTER FREQUENCY SOUND PRESSURE LEVELS

ACOUSTIC NOISE DATA SHEET

NOISE SOURCE #1 ETZLER, HALLETSVILLE, TEXAS DATE/TIME 1/17/78 (1200-1400)

WIND SPEED AND DIRECTION NW-6TO10MPH RELATIVE HUMIDITY 90-100

OPERATOR MLW/DWB

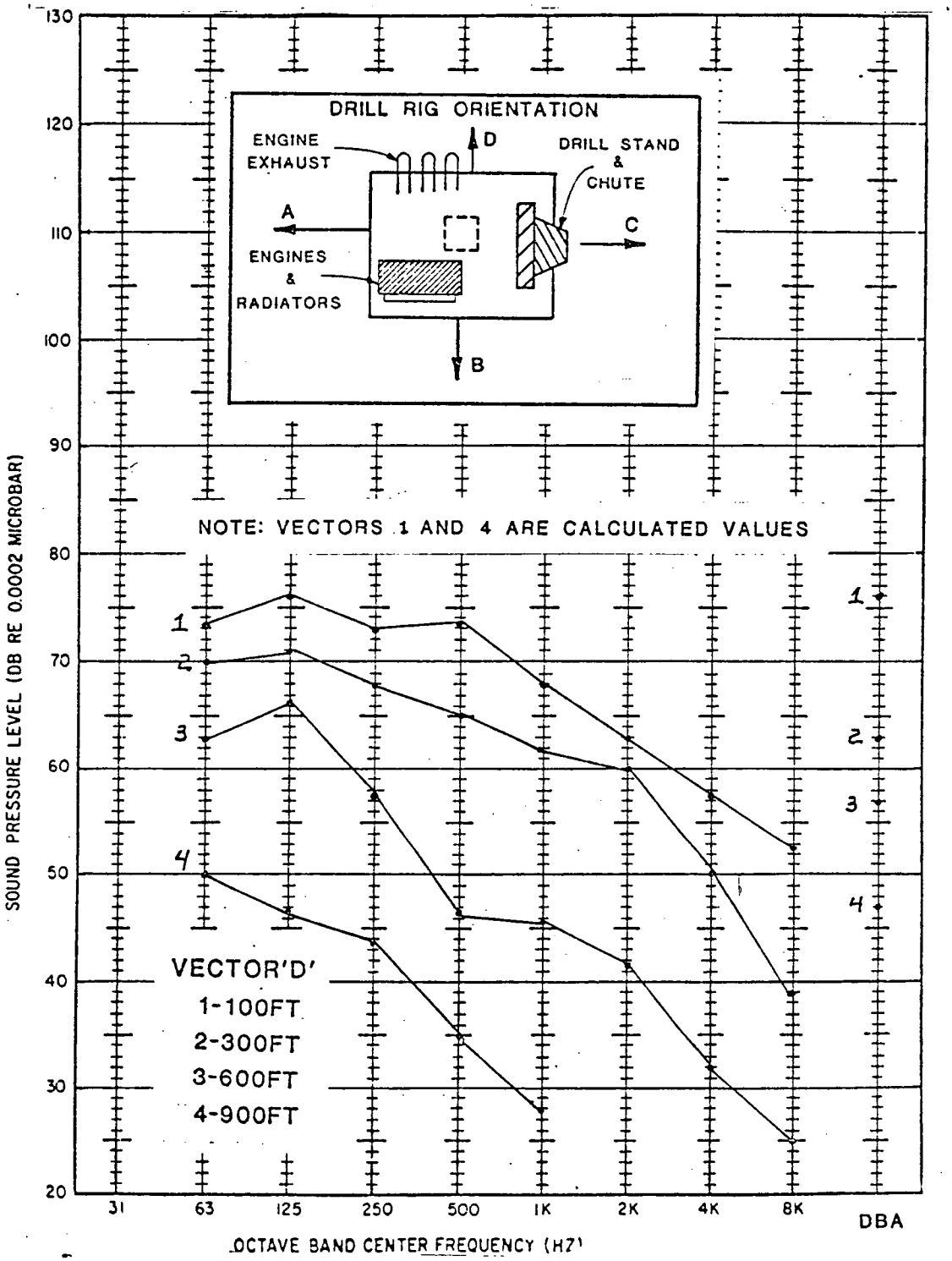


FIGURE 4. MEASURED "A" WEIGHTED AND OCTAVE BAND CENTER FREQUENCY SOUND PRESSURE LEVELS

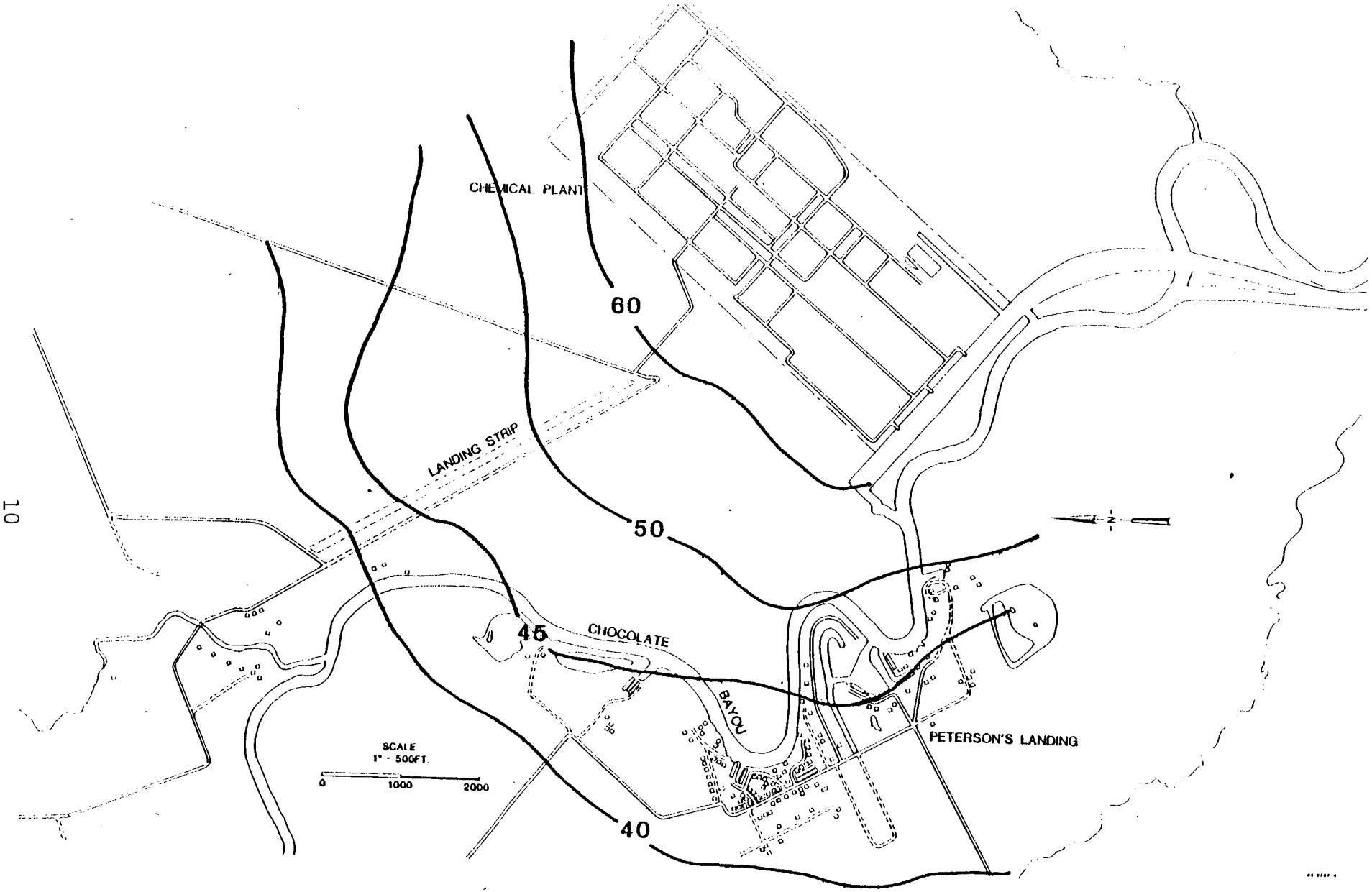
2.2 Peterson Landing Community Baseline Noise Survey

At the Peterson Landing area, noise measurement locations were pre-selected based upon the drilling rig location and the land use in the proximal area. An initial dBA sound pressure level survey was performed on January 19, 1978. This exercise consisted of measuring the ambient dBA levels every 1500 to 2000 feet within the residential area surrounding the proposed geothermal/geopressure well site. Other noise data also compiled were measurements made every 1000 feet parallel to the road leading to the Monsanto Chemical plant. The resulting sound level contours are shown in Figure 5.

An intense 24-hour measurement program was performed on January 27 and 28, 1978 at the same pre-selected points surrounding the concerned area. These additional baseline data were achieved during three 8-hour periods, 0700-1600, 1600-2100, and 2100-0700. These data were compiled and yielded a description of the ambient noise levels existing around the Peterson Landing area over a 24-hour period (L_{dn}). The results, as a function of time of day, are shown in Figures 6, 7, and 8.

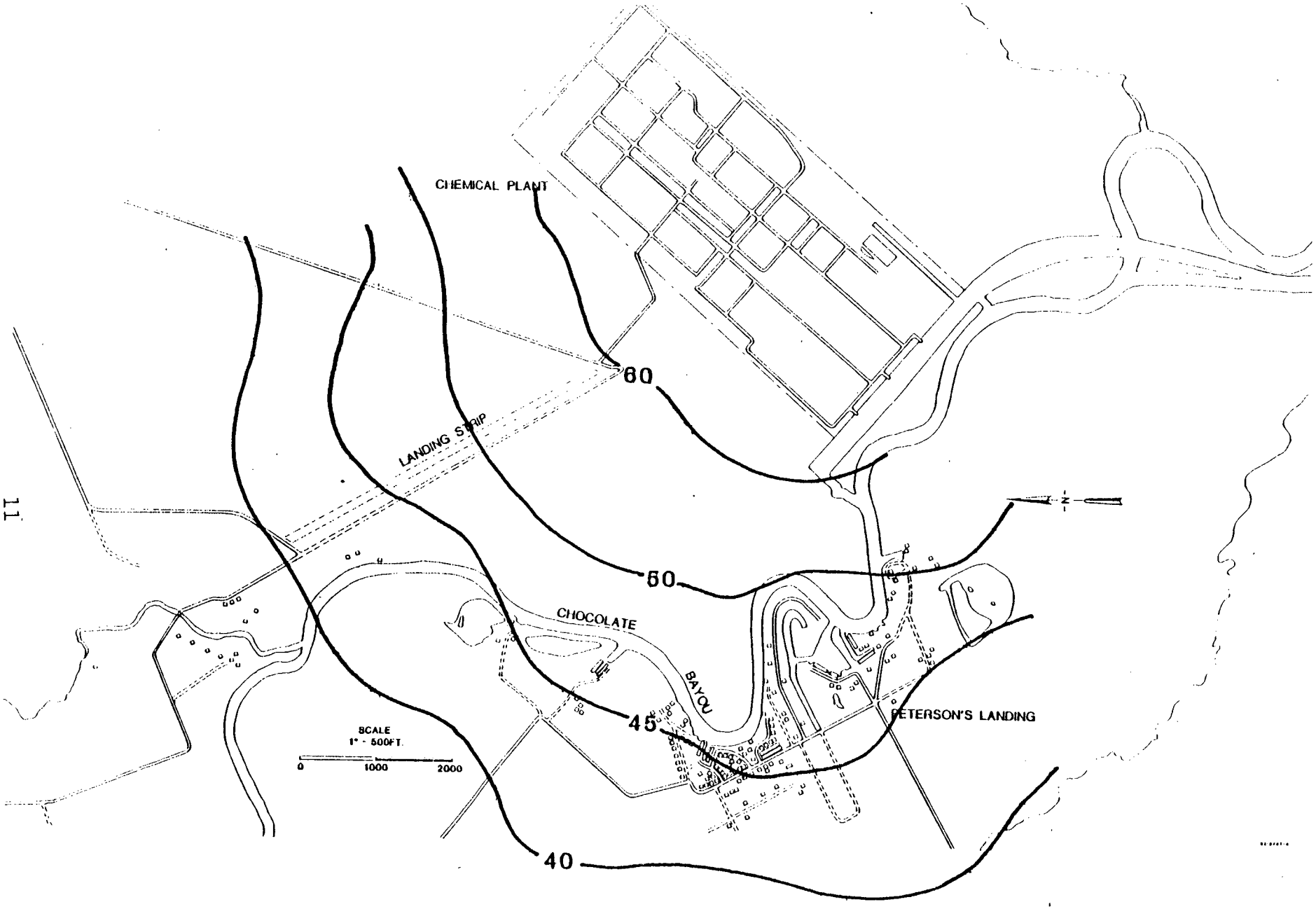
The baseline ambient results show a definite influence from the Monsanto Chemical plant radiated noise. The variations in the 24-hour SPL data can be attributed to Monsanto production changes, steam blow-off, and low frequency flare noise.

In general, all field measurements were made in accordance with ASNI S1.13-1971, Methods for the Measurement of Sound Pressure Levels. Standard non-acoustical data (temperature, humidity, wind speed, etc.) along with observed extraneous influences were logged periodically during each measurement period. Calibration of the instrumentation was performed prior to, during, and subsequent to each sample exercise. The instrumentation used satisfies the specifications for sound level meters.



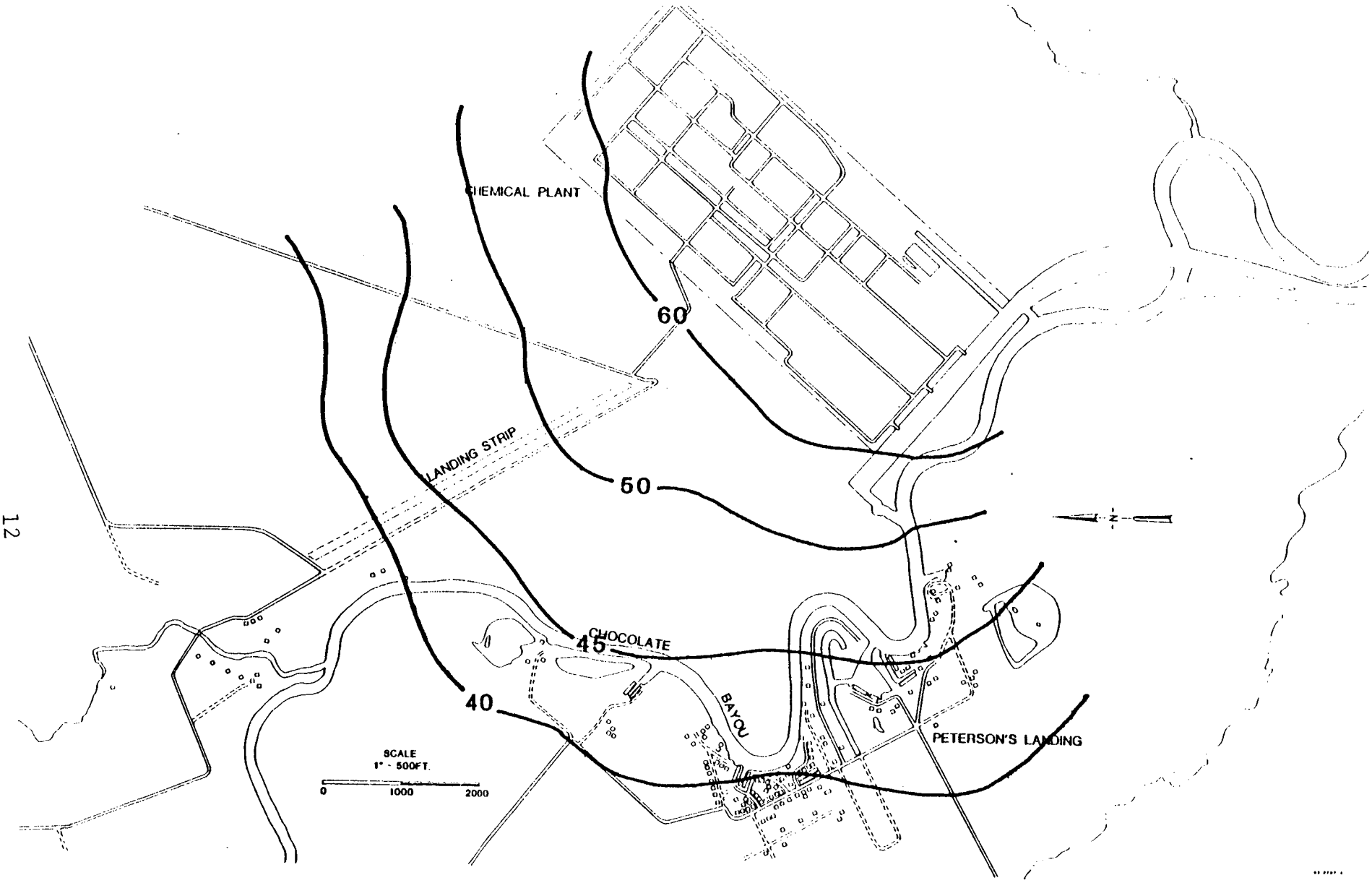
MEASURED AMBIENT NOISE LEVELS IN dBA
JANUARY 19 (1200-1600)

FIGURE 5



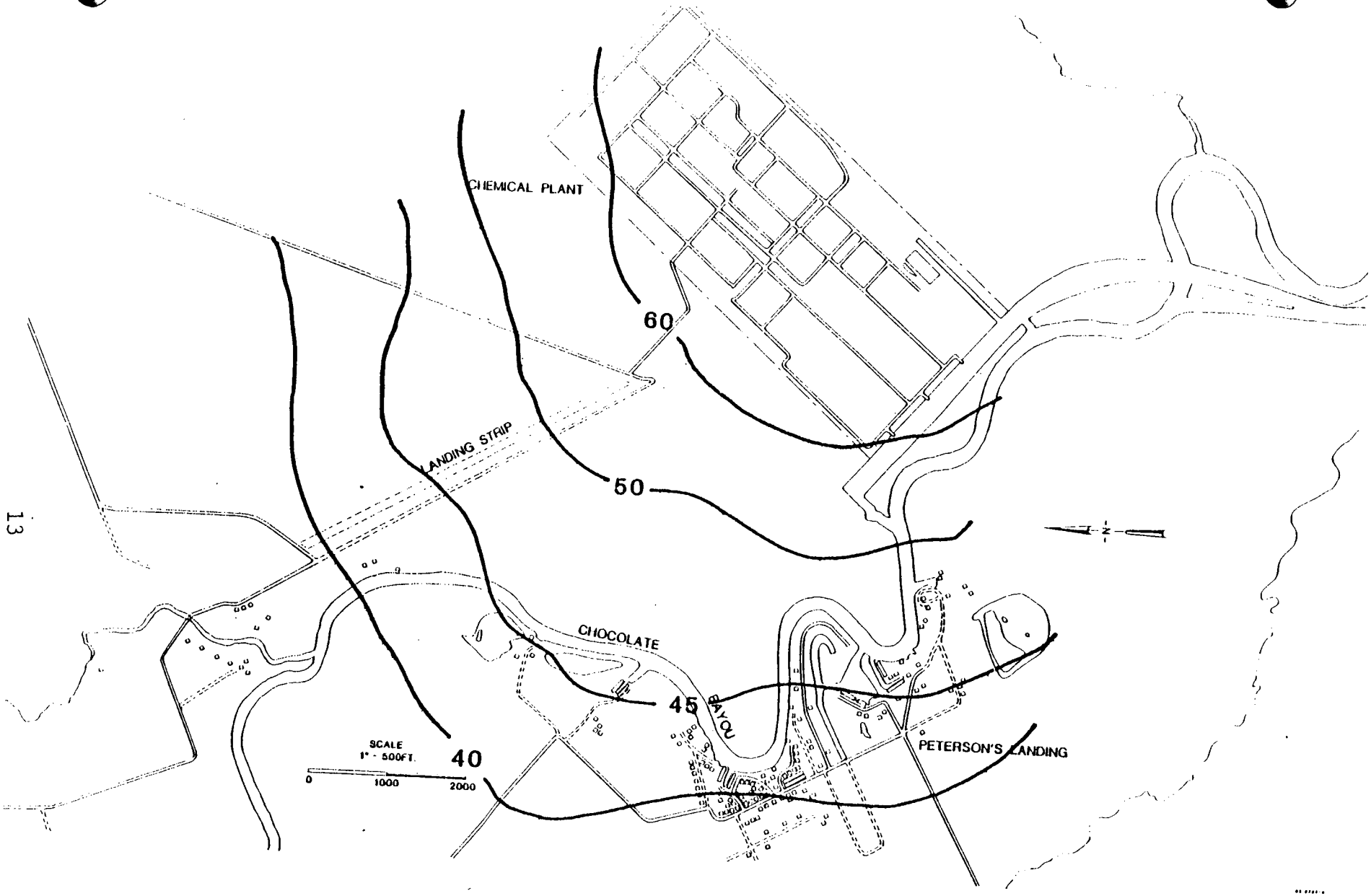
MEASURED AMBIENT NOISE LEVELS IN dBA
JANUARY 29 (0000-0700)

FIGURE 6



MEASURED AMBIENT NOISE LEVELS IN dBA
JANUARY 29 (0700-1300)

FIGURE 7



MEASURED AMBIENT NOISE LEVELS IN dBA
JANUARY 29 (1300-2100)

FIGURE 8

2.3 Noise Field Predictions

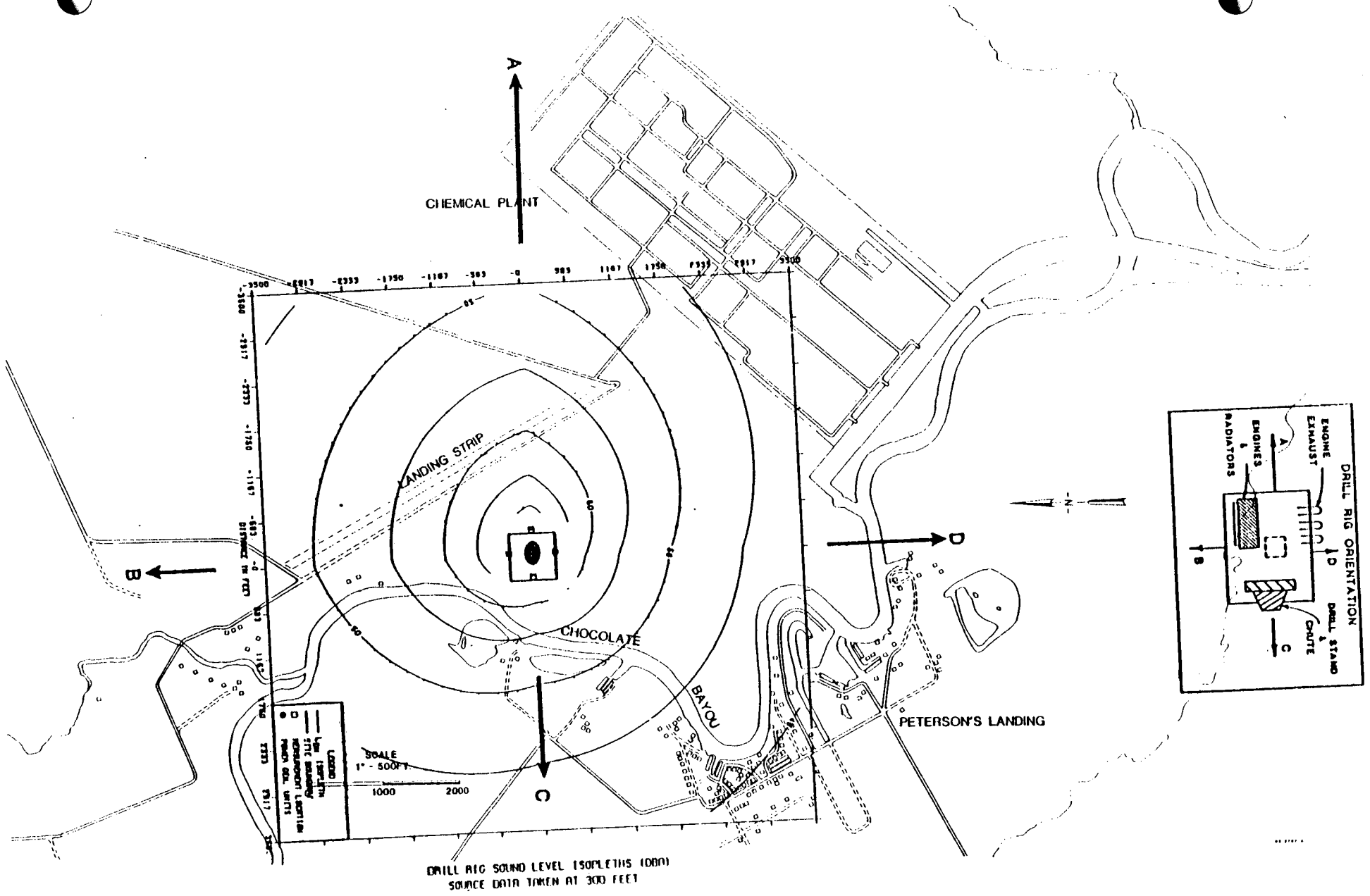
The prediction of noise fields caused by acoustical radiation from a well drilling operation involves consideration of many complex and interacting mechanisms. Many source and propagation factors combine in a complicated fashion in establishing the noise level at a point of interest. From a source standpoint, the radiated noise characteristics are a function of drilling speed, acoustical silencing properties, age and maintenance condition. The radiated sound is influenced by several propagation factors such as temperature, humidity, wind, and physical barriers.

To accommodate such a numerous and diverse set of variables in the prediction of drilling operation noise, sophisticated analytical techniques are required. Such techniques incorporated in Radian's Environmental Noise Prediction Model (ENPM) were employed for predicting noise related to the Chocolate Bayou well drilling operation.

The ENPM, presented in detail in Appendix A, is a computer program which calculates the noise levels in a community due to the effect of an acoustic source. The acoustic source in this application is the 2100 HP drilling facility. The drilling rig is described in the model by its location, sound pressure spectrum, and radiated sound level as a function of direction. The drilling facility acoustic source characteristics were inferred from measurements of the sound pressure spectrum generated by the facility at Hallettsville, Texas.

The ENPM first describes the frequency and directional characteristics of the drilling facility. Then it calculates the propagation losses from the source to the concerned area. These propagation losses include geometric spreading, molecular absorption,

and vegetation attenuation. By factoring in these variable effects on the acoustic source (drilling facility), the total sound pressure spectrum can be obtained at any given far field point within the concerned area. The resulting predicted sound pressure levels (L_{dn}) are shown overlain on the Peterson Landing site map in Figure 9.



DRILLING SYSTEM NOISE PREDICTION

FIGURE 9

3.0 EVALUATION OF IMPACTS

This section discusses the criteria, assumptions, mitigating measures, results of the mathematical modeling predictions and impact on existing community noise levels of the noise emission from the proposed drilling system.

3.1 Establish Evaluation Criteria

The environmental noise guideline criteria adopted for this evaluation is documented in EPA's "Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." These criteria are generally accepted as a valid approach to assessing the response of humans to environmental noise.

To quantitatively measure the impact of noise, EPA recommends the use of a measure, L_{dn}, the long-term equivalent A-weighted sound level (a single value measure that approximates sound as processed by the human ear) with an adjustment to account for differences in response during daytime and nighttime periods.

The data acquired during the various measurements provide the basis for computing L_{dn} to describe baseline conditions in these terms. The predicted noise effects from the drilling system is also in terms of L_{dn} in order to assess the expected human response to noise associated with the project.

A complete discussion of the quantitative levels of noise, expected human response, and the criteria against which predicted impact was evaluated are presented in Appendix B.

3.2 Mitigating Measures

The drilling system noise impact can be mitigated by appropriately positioning the system such that the major radiated acoustical lobes are directed away from inhabited areas.

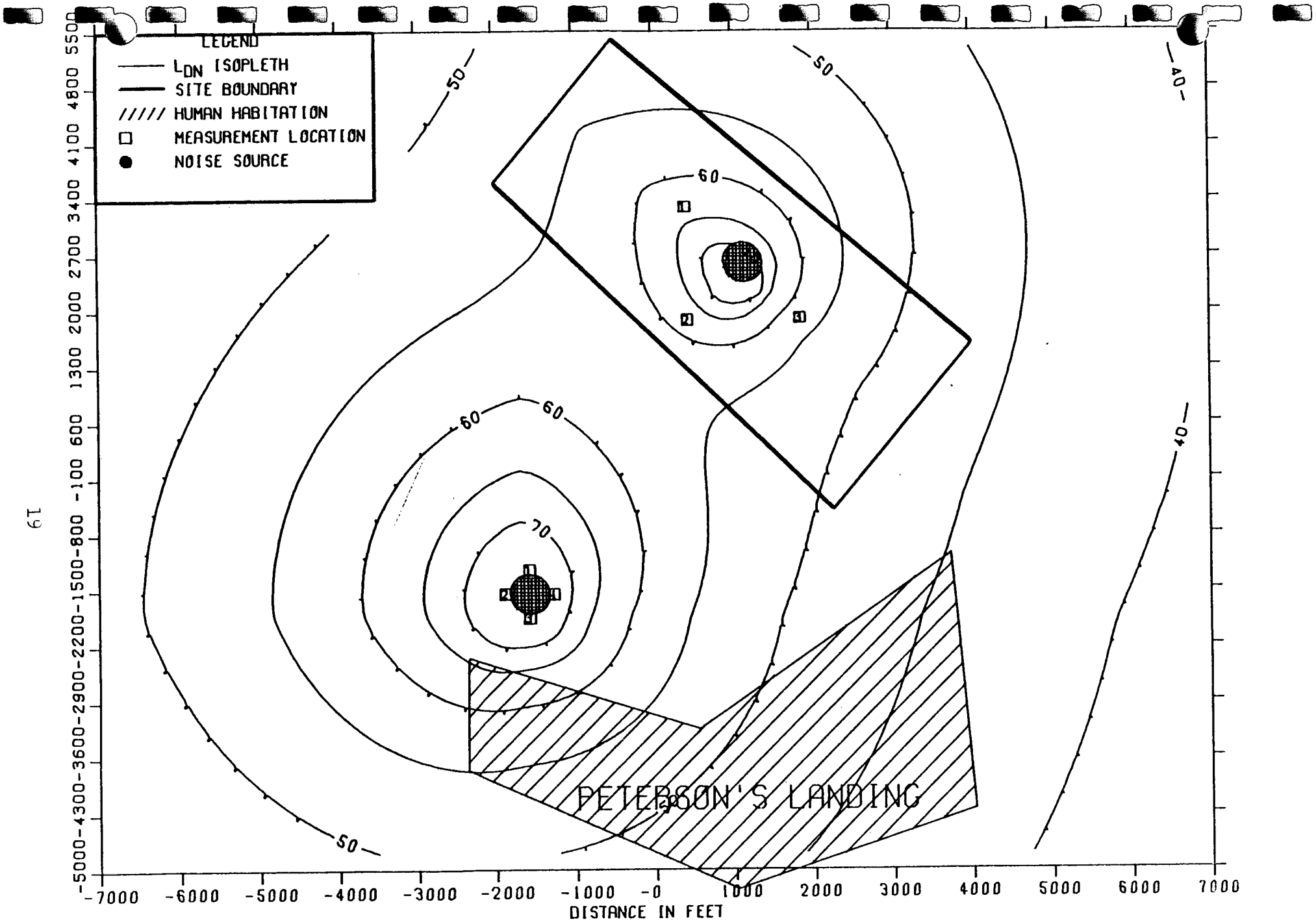
The initial L_{dn} predictions performed are based upon noise radiation characteristics of the drilling system at Hallettsville, Texas and Monsanto Chemical plant near the Chocolate Bayou well site. The ENPM result as shown in Figure 10 indicates that additional noise radiated from the drilling system will have no appreciable environmental effect on the Peterson Landing community and residents along the concerned portion of the Chocolate Bayou.

3.3 Interpretation of Results

The assessment of environmental noise impact is based upon the criteria of Appendix B, the predicted levels of Section 3.2, and results of an operational period noise survey throughout concerned areas.

An estimate of the expected reaction of a community to intruding noise comprised of many types is depicted in Figure 11. The figure shows the percentage of people annoyed as a function of L_{dn}. It can be seen that 17% of the people become annoyed when L_{dn} is around 55 dB. Organized community response and legal action may be expected when noise levels exceed 65 dB or more.

A review of Figure 11 illustrates that within the Peterson Landing area, noise levels of 45-50 dB within the residential area would be acceptable as noise of this range currently exists. Introducing noise of 45-50 dB would increase



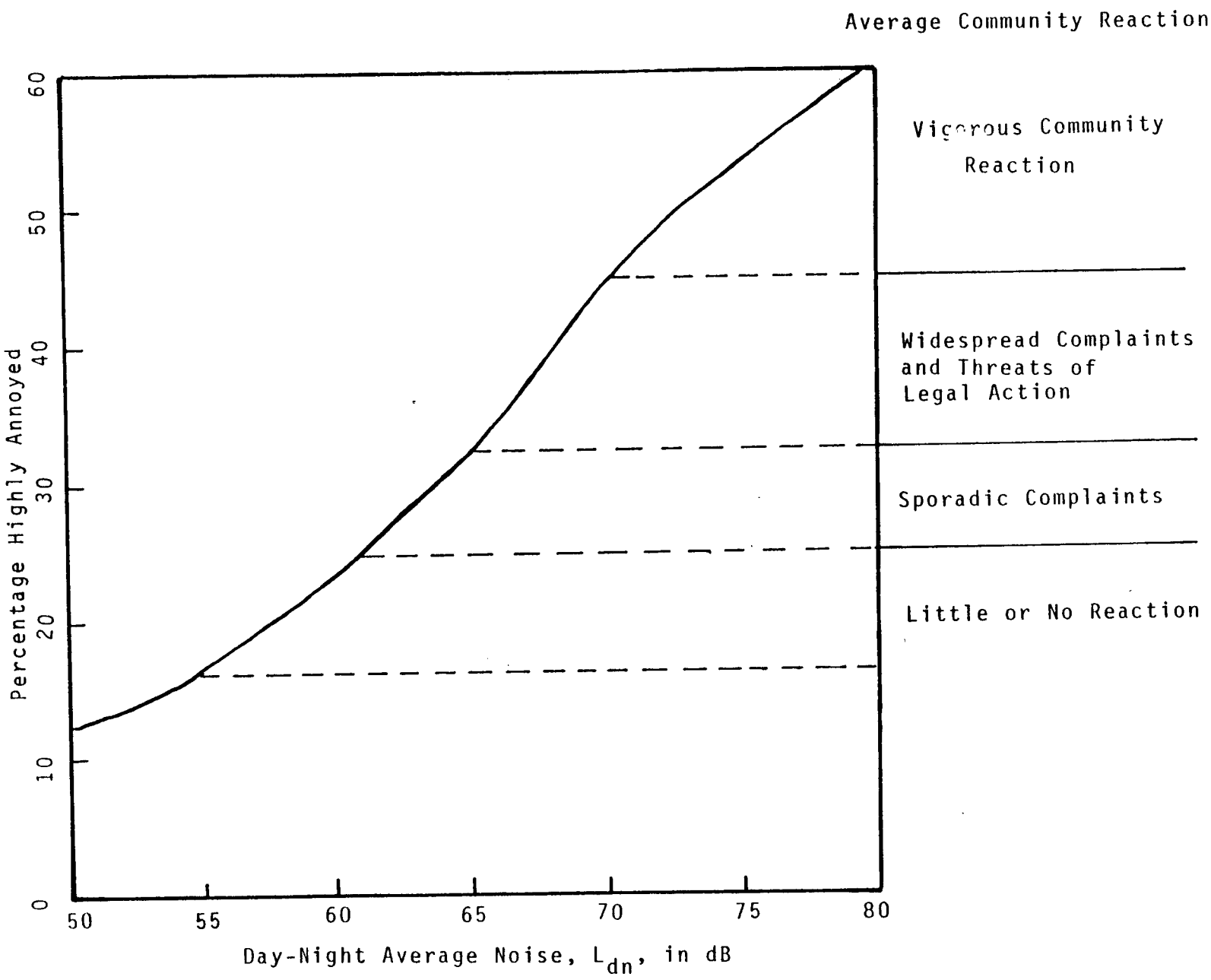
CHEMICAL PLANT AND DRILLING SYSTEM NOISE FIELD PREDICTIONS

FIGURE 10

the level nominally of about 3 dB, a value that is hardly discernible. The drilling system noise prediction shown in Figures 9 and 10 illustrates an additional noise of 40-50 dB throughout the northwestern corner of Peterson Landing residential area. These resulting levels are within the guidelines for health and welfare as recommended by EPA.

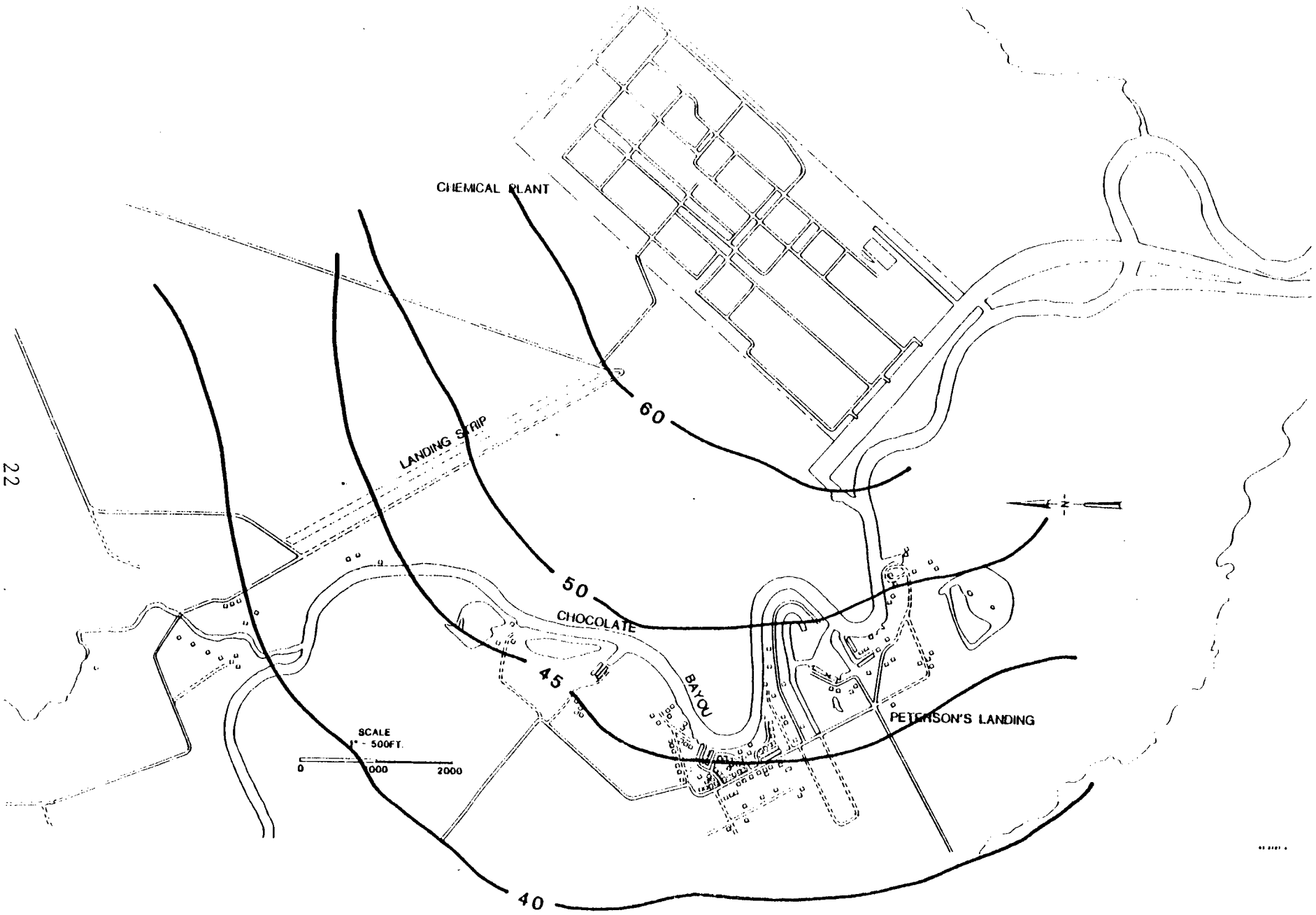
On August 4 and 5 a final 24-hour noise survey was performed during normal drilling operation phases. During the survey it was found that a new 4800 HP drilling system was being used in place of the proposed 2100 HP system. The new and more powerful system was found to be approximately 17 to 20 percent quieter due to sound-proof engine enclosures. During normal operation only 2 of the 3 1600 HP engines are running.

The 24-hour exercise was performed at the same preselected locations as the previous survey. The resulting sound level contours for 0700-1600, 1600-2100, and 2100-0700 hours are shown in Figures 12, 13, and 14. Comparison of the 24-hour data with drilling activity with the previous 24-hour ambient data reveals only minor differences. From these observations, it can be seen that the Monsanto Chemical facilities provide more than adequate background noise necessary to mask the concerned drilling operation noise.



MEASURES OF INDIVIDUAL ANNOYANCE AND EXPECTED COMMUNITY REACTION

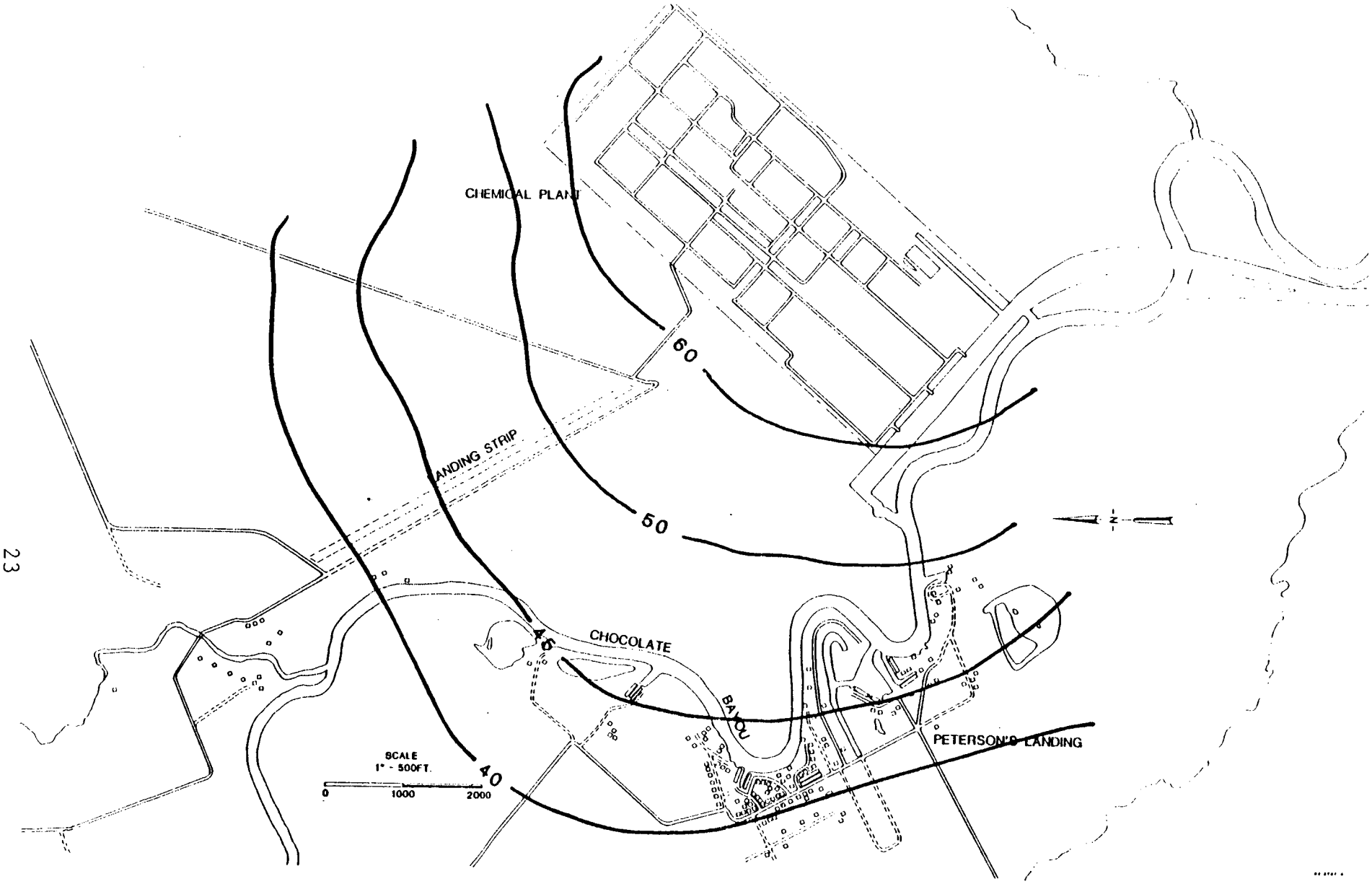
FIGURE 11.



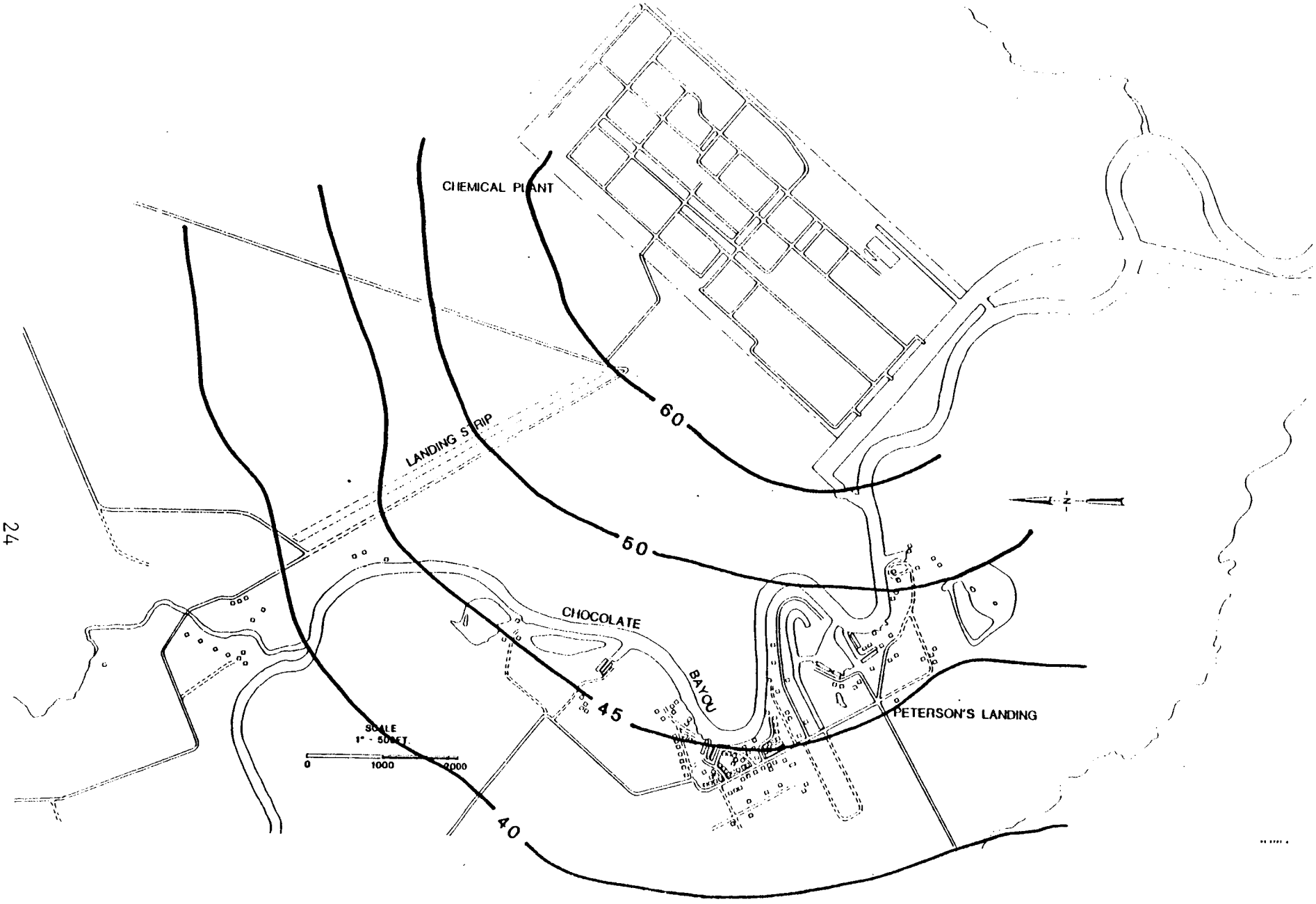
MEASURED AMBIENT NOISE LEVELS IN dBA

AUGUST 5 (0700 - 1600)

FIGURE 12



MEASURED AMBIENT NOISE LEVELS IN dBA
AUGUST 5 (1600 - 2100)
FIGURE 13



MEASURED AMBIENT NOISE LEVELS IN dBA

AUGUST 5 (2100 - 0700)

FIGURE 14

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APPENDIX A

ENVIRONMENTAL NOISE PREDICTION MODEL (ENPM)

The environmental noise model is a computer program which calculates the noise levels in a community due to the combined effects of several acoustic sources. The sound pressure level is calculated at each of a rectangular array of "grid points" distributed over the community area of interest. Figure A-1 outlines the steps involved in these calculations.

The first step is to describe the frequency and directional characteristics of each acoustic source. This may be accomplished by specifying each piece of equipment's location, sound power spectrum, and directivity pattern. Alternately, these source characteristics may be inferred from measurements of the sound pressure spectrum at several locations about the source. Next, the propagation losses from each source to each grid point are calculated. By summing the contribution from each source, the total sound pressure spectrum is obtained at each farfield grid point. By properly weighting in frequency and time, the levels are converted to units of L_{dn} (day-night average sound level). Contours of equal sound levels (L_{dn} isopleths) are determined by linear interpolation between grid points.

Source Description

Each acoustic source is described in the model by its location, sound pressure spectrum, and radiated sound level as function of direction. The model handles directional patterns by inputting the sound level in arbitrarily selected directions. The sound level is then linearly interpolated in the other directions.

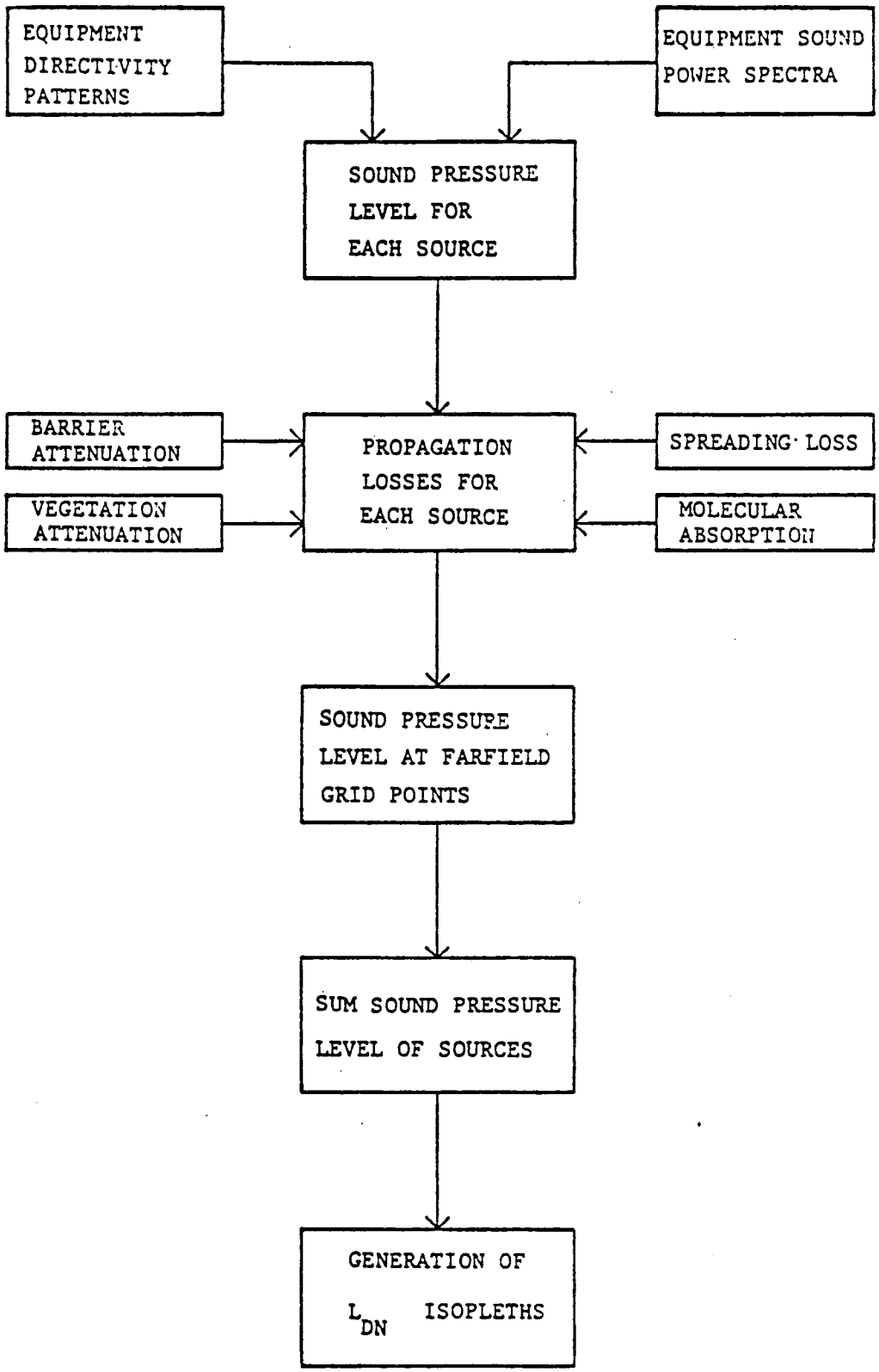

FIGURE A-1 - SCHEMATIC OF ENVIRONMENTAL NOISE PREDICTION MODEL

The model has a provision for using sound pressure spectral measurements at arbitrary locations to characterize an acoustic source. The sound is assumed to be entirely due to a single source at a specified location. In the example of Figure A-2 the measurements are at locations M_1, M_2, and M_3. The propagation loss portion of the model is used to correct each sound pressure spectrum to the arbitrarily selected reference radius (points p_1, p_2, and p_3). Interpolation of the sound field between the measured directions provides a complete description of the sound field due to the acoustic source.

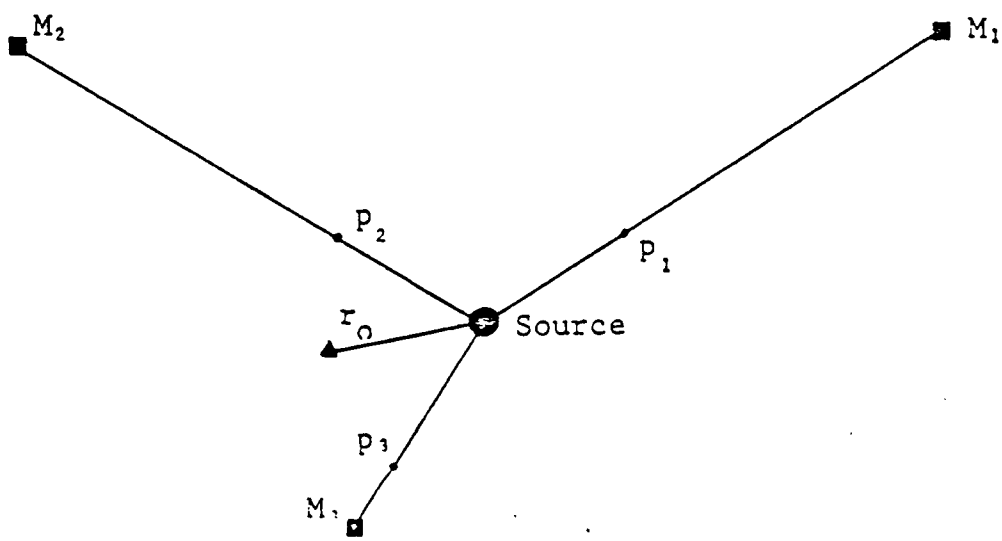

FIGURE A-2

Propagation Losses

The intensity of sound waves changes with propagation for several reasons. Geometric spreading losses occur when the area covered by a wavefront increases with time. Molecular absorption is the transfer of energy from the ordered sound

waves to random molecular vibrations and to higher molecular translational kinetic energies. Vegetation attenuation is due to the absorption of sound energy by grasses, trees, bushes, etc. Barriers reflect and diffract sound energy. The individual propagation effects are discussed in more detail below.

Geometric Spreading

Consider sound waves due to a point source which radiates uniformly in all directions. When the sound waves emitted at time t_o have traveled a distance r_o, the wavefronts are evenly distributed over a spherical surface to radius r_o. The radiated sound energy E is evenly distributed over this surface, which has an area $4\Pi r_o^2$. The intensity, or energy per unit area, is the sound parameter perceived by the human ear and by microphone. The intensity is $E/4\Pi r_o^2$.

Thus the effect of the geometric spreading is that the intensity varies as the inverse square of the distance of the receiver from the source. In terms of sound pressure level, this is a 6 dB loss per distance doubling.

Molecular Absorption

As sound waves propagate through the atmosphere, some energy is lost to the molecules in the air. Two mechanisms contribute to this loss. First, the compressions and rarefactions due to traveling sound waves can jolt some molecules into higher energy vibrating states. The other effect is slightly higher average molecular kinetic energies after passage of a sound wave. This may be thought of as using some of the sound energy to raise (very slightly) the temperature of the gas.

Both molecular absorption mechanisms are highly frequency dependent. More energy is lost at higher frequencies than at lower frequencies. The attenuation is constant when expressed in units of dB loss per unit length. This means that for a given length of sound travel, the fraction of the total sound energy which is lost to molecular energy is constant.

At sound ranges up to 2,000 feet from the source, geometric spreading is the major propagation loss factor. Beyond 2000 feet from a source, the molecular absorption losses are most important. At distances beyond a mile, small differences in attenuation coefficients will cause substantial differences in sound pressure level predictions. Besides frequency, molecular absorption depends on temperature, humidity, and micrometeorological disturbances.

The values of sound attenuation coefficients used in the Vickers' noise impact study are listed in Table A-1. These values should be adequate up to ranges of about two miles. For larger ranges, attenuation coefficients matched to the appropriate humidity, temperature, and air stability for each situation should be used.

TABLE A-1
ATTENUATION COEFFICIENTS FOR SOUND PRESSURE LEVEL
LOSSES DUE TO MOLECULAR ABSORPTION

Frequency (Hz)	62.5	125	250	500	1000	2000	4000	8000
Attenuation Coefficient (dB/1000 ft.)	1.0	1.5	2.0	2.5	3.0	4.0	8.0	15.0

Vegetation Attenuation

Sound energy can also be lost to vegetation, such as grasses, bushes, and trees. The amount of attenuation depends on the type of vegetation and on the path of the sound wave. Generally speaking, as the vegetation more completely blocks the direct-line path from source to receiver, the attenuation increases. This loss is frequency dependent. As in molecular absorption, it is constant when expressed in units of dB per unit distance.

Barrier Attenuation

Another form of attenuation is due to obstacles which partially obstruct the sound path. This causes losses because of reflection and diffraction of sound waves. Typical barriers include walls, buildings, and storage tanks. For some types of barriers (e.g., housing developments), the loss can be represented fairly accurately by a constant number of dB per unit distance, together with a maximum allowable loss. For other barriers, such as walls, the loss is a rapid drop in level at the barrier edge. The computer model can handle both of these types of barriers at arbitrary locations.

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APPENDIX B

NOISE EVALUATION CRITERIA

The following discussion presents the basis for evaluating the effect of noise associated with operating a large well drilling system.

1.0 Qualitative Considerations

The degree to which humans are disturbed or annoyed by noise is dictated by a number of factors. However, it is generally agreed that the response to unwanted sound (i.e., noise) depends upon three things:

> The strength and character of the intruding noise,
>
> The level of background (ambient) noise existing prior to introduction of the intruding noise, and
>
> The type of working or living life styles of humans occupying the area under study.

It is helpful in evaluating the effect of added noise to the environment to have a qualitative feel for each of these factors. Methods for quantitative assessment will be discussed later. The discussion below provides a "relative" assessment of factors relating noise to human response.

The strengh and character of intruding noise are described by (1) the frequency distribution of the noise, (2) the noise level, and (3) the time pattern of noise.

Considering the first, human hearing sensitivity is more acute in the high frequency region than in the low frequency

region. Consequently high frequency noise will be judged as "more pronounced" by listening. To accommodate this spectral distribution with a simple prediction of human response, the A-weighted measure of sound was devised. This measure emphasizes the high frequency content of noise while rejecting some of the low frequency content in a similar fashion as the ear does. The A-weighted sound level has been demonstrated to be an accurate measure for evaluating the effects of noise on speech communication, hearing hazards, and human disturbance and annoyance.

The effect of the intensity of noise is rather obvious. With increasing level comes increasing difficulty in hearing communications and consequently increased indignation or annoyance toward the intruding noise. At very high noise levels and with continued exposure, the hazard of hearing loss becomes a reality.

The temporal or time pattern of noise becomes important because humans adapt more readily to a smooth, rather broadband noise intrusion than one that is intermittent or unexpected. For example, impulsive noise such as that associated with pile drivers or intermittent noise such as from blow-off valves are readily identifiable and can be the cause of annoyance. Sources that are identifiable have been shown to be more disturbing than those than are not. The time that the noise occurs is equally important. Noise that interferes with sleep, TV-watching, communication, etc., will generate considerable negative response from listeners.

The second factor, <u>level of ambient noise</u>, is important because humans tend to judge added and intruding noise on the basis of the noise that was present prior to the time that the new noise was introduced. If the new noise has character that is readily

identifiable and exhibits distinctive sounds, such as railroad car switching or the whine of engines, it will be readily noticed by residents and may be judged as objectionable. Added noise of the same character as ambient will be less noticeable by residents. For example, higher noise levels from increased traffic activity will still manifest noise character similar to existing levels, and will hardly be noticed by neighbors and probably will not be considered as objectional.

The third factor, having to do with living styles of near vicinity residents, concerns their working and living patterns. In quiet rural areas, one might expect considerable objection to intruding noise wile attempting to sleep. Conversely, this same noise may not be noticeable to an office worker in the city.

In summary, the following qualitative guidelines are applicable to estimating effects of noise:

1) If the intruding noise is significantly above ambient noise, adverse reaction is likely.

2) Noise that interferes with sleep, speech, or television watching is particularly annoying.

3) Noise possessing prominent discrete tones is much more annoying than broad band noise.

4) Short-duration or frequent changes in noise levels tend to increase annoyance.

2.0 Quantitative Considerations

Based upon many laboratory and field studies, quantitative values of noise level can be related to effects, in general, upon people. Some twenty different measures of noise have been developed and are used in practice. A particular measure is generally adopted to satisfy the specific objectives of a noise evaluation program.

Criteria documented by the Environmental Protection Agency in "Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety" are recommended as the basis for evaluating the effect of noise associated with construction and operation of a refinery complex.

In development of the criteria, EPA did not make a distinction between health and welfare, but defined health as the World Health Organization does as "a total physical, physiological and psychological well-being of the individual and not merely an absence of disease or infirmity". (Therefore, speech communication, sleep disturbance, hearing hazards, etc., fall into the area of health and welfare.)

To quantitatively assess the impact of noise, EPA recommends the use of a measure, L_{dn}, the long-term equivalent A-weighted sound level with a weighting to account for difference in response during daytime and nighttime periods. Mathematically L_{dn} is expressed as:

$$L_{dn} = 10 \log \frac{1}{24} \left[15(10^{L_d/10}) + 9(10^{\frac{L_{n+10}}{10}}) \right] \text{dB}$$

L_d = Long-term equivalent A-weighted sound level (l_{eq}) for daytime (0700 to 2200 hours)

$$L_n = L_{eq} \text{ for nighttime (200 to 0700 hours)}$$

which essentially states that a 10 dB penalty is applied for nighttime operations. For the purposes of this program, it may be assumed that L_{eq} is measured or predicted sound level approximated by a normal distribution having a standard deviation equal to zero and that the levels are those that are exceeded 50% of the time.

Table B-1 summarizes noise level limits in terms of L_{dn} and L_{eq} considered essential to protect public welfare and safety. Note that L_{dn} = 55 dB and L_{eq} = 55 dB are values that are representative of most conditions in the vicinity of the proposed refinery. For more detailed characterizations, the EPA "levels" document should be examined. This table serves as the basis for general assessment of environmental noise as required by this program. Further refinement of these can be achieved by considering the factors discussed below.

The ability to communicate effectively depends upon the presence and level of ambient or "masking" noise. The values of Table B-2 illustrate the person-to-person separation that will permit 95% speech intelligibility in the presence of different A-weighted sound levels and vocal efforts. The data are representative of male voices with individuals face-to-face outdoors.

Additional evaluation may be made by considering the effect of noise upon communications by telephone. The quality of telephone usage in the presence of steady-state masking noise may be obtained from Table B-3.

TABLE B-1

SOUND LEVELS REQUIRED TO PROTECT PUBLIC HEALTH AND WELFARE

EFFECT	LEVEL	AREA
Hearing Loss	$L_{eq(24)} \leq 70$ dB	All areas
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} \leq 55$ dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas
	$L_{eq(24)} \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

TABLE B-2

MAXIMUM A-WEIGHTED SOUND LEVELS THAT WILL PERMIT ACCEPTABLE SPEECH COMMUNICATION FOR VOICE LEVELS AND LISTENER DISTANCES SHOWN

	Ambient Sound Level in dBA			
	Vocal Effort			
Distance (Ft)	Low	Normal	Raised	Very Loud
1	60	66	72	78
2	54	60	66	72
3	50	56	62	68
4	48	54	60	66
5	46	52	58	64
6	44	50	56	62
12	38	44	50	56

TABLE B-3

QUALITY OF TELEPHONE USAGE IN THE PRESENCE OF STEADY-STATE MASKING NOISE

Noise Level (dBA)	Telephone Usage
30-50	Satisfactory
50-65	Slightly Difficult
65-75	Difficult
Above 75	Unsatisfactory

The change in ambient sound level is an important factor in assessing the impact from added noise sources. It is possible to just detect a 2-3dBA change while a 5 dBA change is readily apparent. A 10-decibel increase is judged by most people as a doubling of the loudness of sound and each 10-decibel increase impresses a listener as doubling the loudness. As such, preconstruction ambient level associated with the area becomes increasingly important.

3.0 Wildlife and Domestic Animals

The effects of noise upon wildlife and domestic animals are not well understood. Studies of animals subjected to varying noise exposures in laboratories have demonstrated physiological and behavioral changes and it may be assumed that these reactions are applicable to wildlife. However, no scientific evidence currently correlates the two.

It is known that large animals adapt quite readily to high sound levels. Conversely, it has been demonstrated that loud noises disrupt broodiness in poultry and consequently can affect egg population.

The major effect of noise on wildlife is related to the use of auditory signals. Acoustic signals are important for survival in some wildlife species. Probably the most important effect is related to the prey-predator situation. The effectiveness of an animal that relies on its ears to locate prey and that of an animal that relies on its ears to detect predators are both impaired by intruding noise.

In addition, the reception of auditory mating signals could be limited and, therefore, affect reproduction. Distress or warning signals from mother animals to infants (or vice versa) or within groups of social animals could be masked and possibly lead to increased mortality. There are clues that short-term high noise level may startle wild game birds and stop the brooding cycle for an entire season.

The effects are only qualitative and as such, comprise criteria than can be used as guidance only.