ACOUSTICAL TEST OF PROMPT ALERTING SYSTEM FOR SAN ONOFRE NUCLEAR GENERATING STATION

(Test Date: 24 May 1982)

Prepared for

SOUTHERN CALIFORNIA EDISON COMPANY
Rosemead, California 91770

Prepared by

WYLE RESEARCH
El Segundo, California 90245

(J/N 39145)

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1.0 INTRODUCTION

A prompt alerting system consisting of 40 sirens* has been installed within the 10-mile Emergency Planning Zone (EPZ) of the San Onofre Nuclear Generating Station (SONGS). The system is deployed throughout community, beach front, military, and commercial areas in parts of Orange and San Diego Counties. Control and activation of the system is retained by five agencies; namely:

- o Orange County (OC)
- o San Juan Capistrano (SJ)
- o San Clemente (SC)
- o State Parks (SP)
- o Camp Pendleton (CP)

Locations of the 40 sirens throughout the 10-mile EPZ are illustrated in Figures 1A and 1B. Sirens within each control zone are prefixed with the letter codes shown above.

A test to determine performance of the system was conducted on May 24, 1982, during which all sirens were simultaneously activated and set to operate for a period of 4 minutes. During this test, sound level data comprising ambient background noise levels (pretest and post-test) and siren signal levels, were measured at 28 sites within the 10-mile EPZ.

*These include a previously installed siren owned by the City of San Clemente.

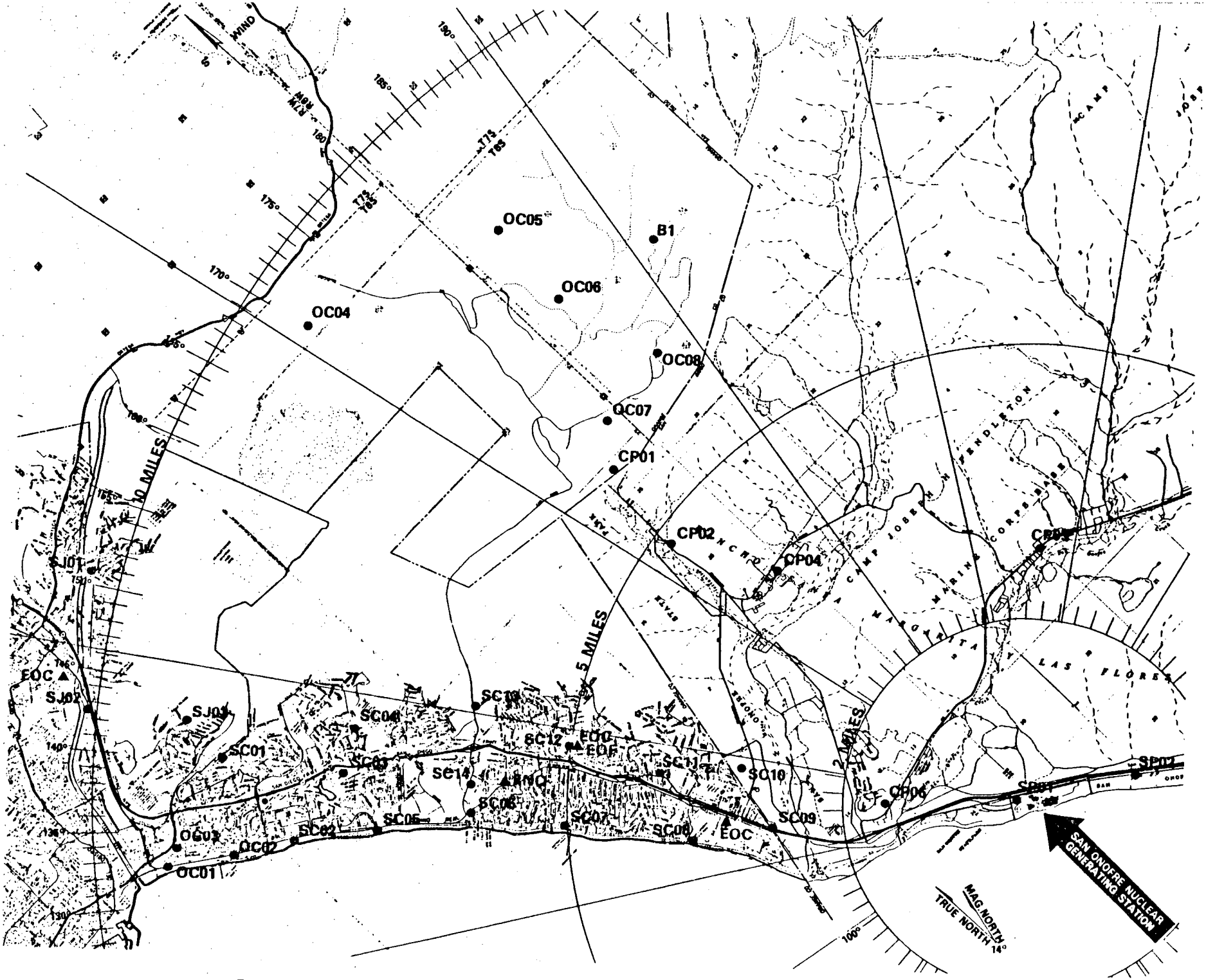


Figure 1A. Northern Half of the San Onofre Nuclear Generating Station EPZ

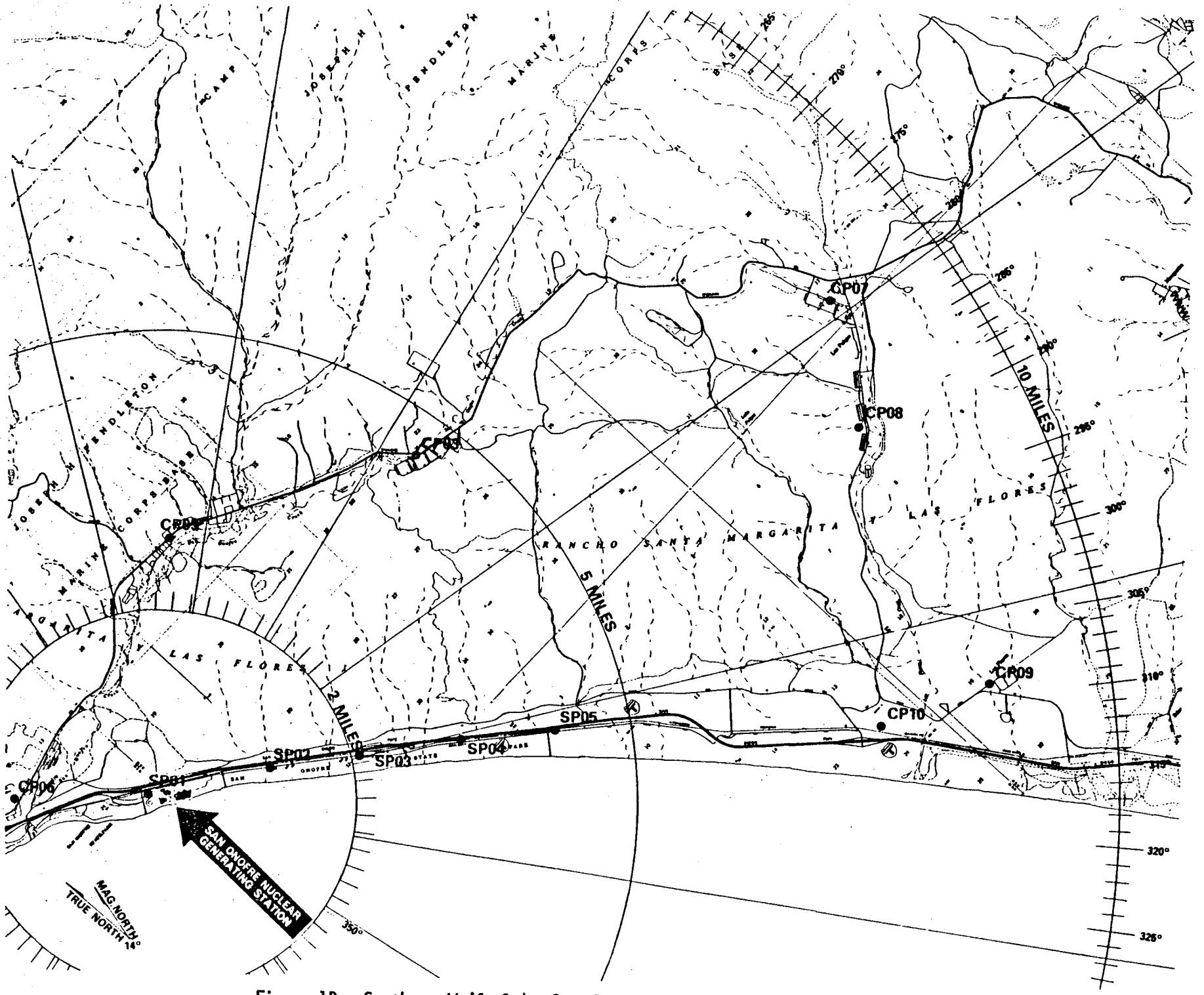


Figure 1B. Southern Half of the San Onofre Nuclear Generating Station EPZ

2.0 TEST PROCEDURES

2.1 Siren System Activation

The siren system activation and test was scheduled to commence at 1415 hours on 24 May 1982. Each controlling agency was to activate its respective sirens after confirmation of readiness by all other agencies. In practice, the system was activated at 1418 hours on the test day. Timer controls of each siren were preset to provide a siren operation period of 4 minutes.

The following is a summary of siren deviations from the scheduled performance:

Sirens not activated:

OC07, OC08, SC04, CP08.

Sirens with foreshortened periods of activation:

CP03.

Sirens with protracted periods of activation:

SJ01, SC01, SC03, SC06, OC04.

All other 30 sirens operated in accordance with the scheduled performance.

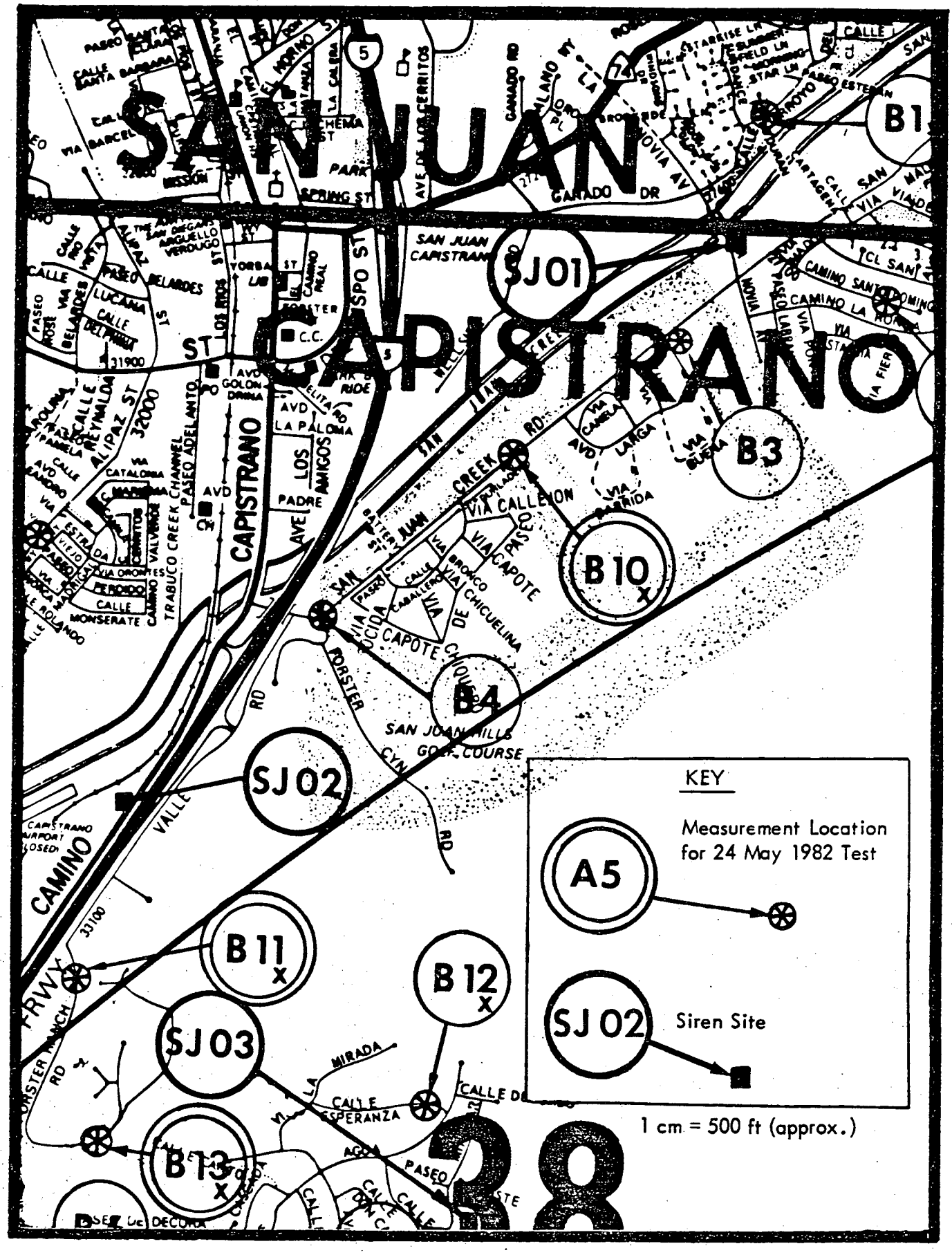
2.2 Sound Measurement Locations

Twenty-nine sound measurement locations were used in the May 24, 1982, test.* These 29 locations comprised the main body of sites at which deficiencies of signal level or signal-to-(ambient) noise were noted in a previous test of the system during January 25 to 29, 1982. The measurement sites were identical to those previously used, which were part of a randomly selected sample of 81 sites covering all control zones and agencies.

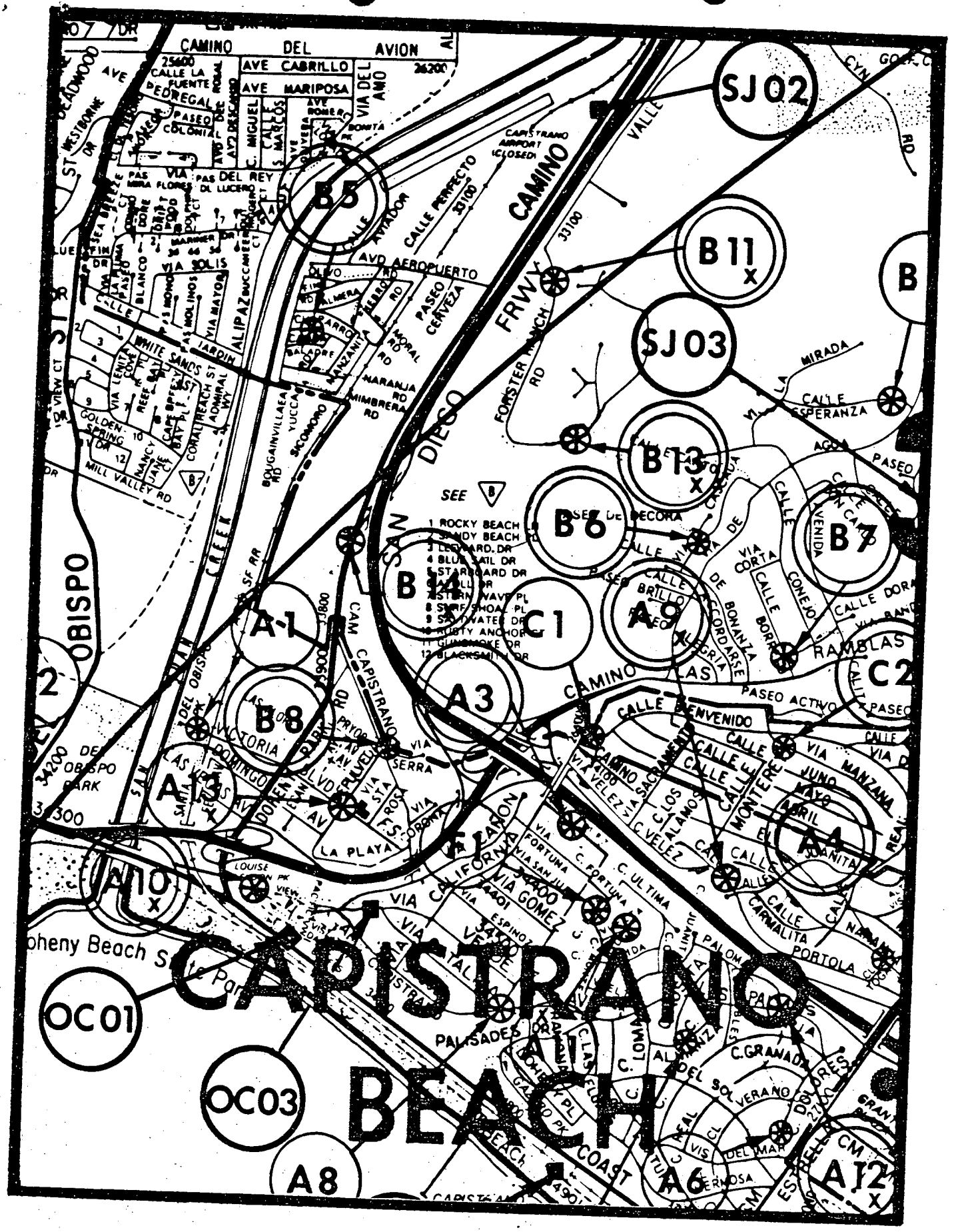
Figures 2(a) through 2(i) show the 29 sound measurement locations (highlighted) in relation to the siren locations. Table I contains a brief description of each sound measurement location, as employed by the respective measurement teams to identify sites.

In each reference to site locations, the following prefixes have been used to relate the sites to the respective zones (agencies):

*Instrumentation failure at one site reduced the number of sites with data to 28.

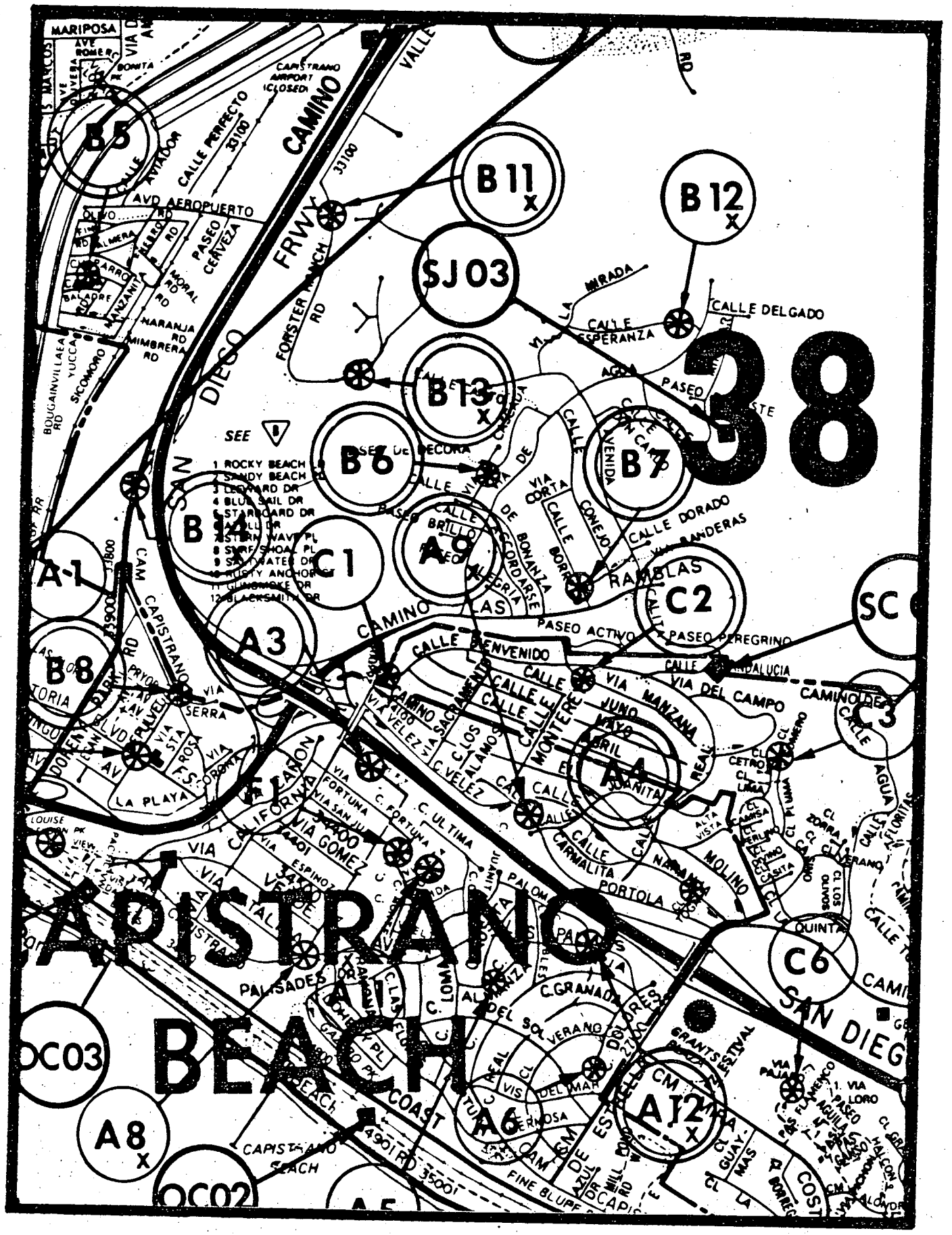


(a) Figure 2. Maps Showing Sound Measurement Locations During Siren System Test of May 24, 1982

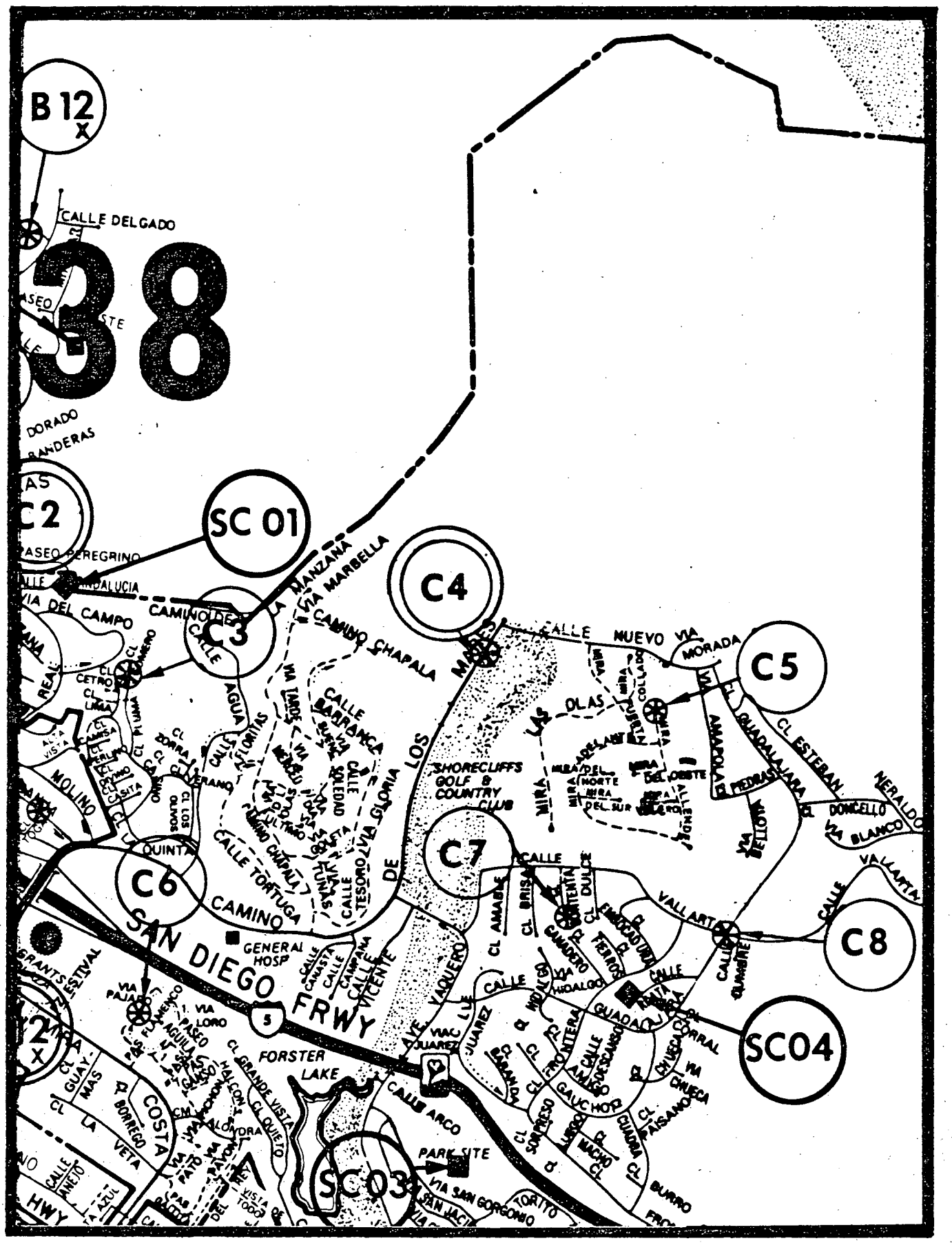


(b)

Figure 2 (Continued)



(c) Figure 2 (Continued)



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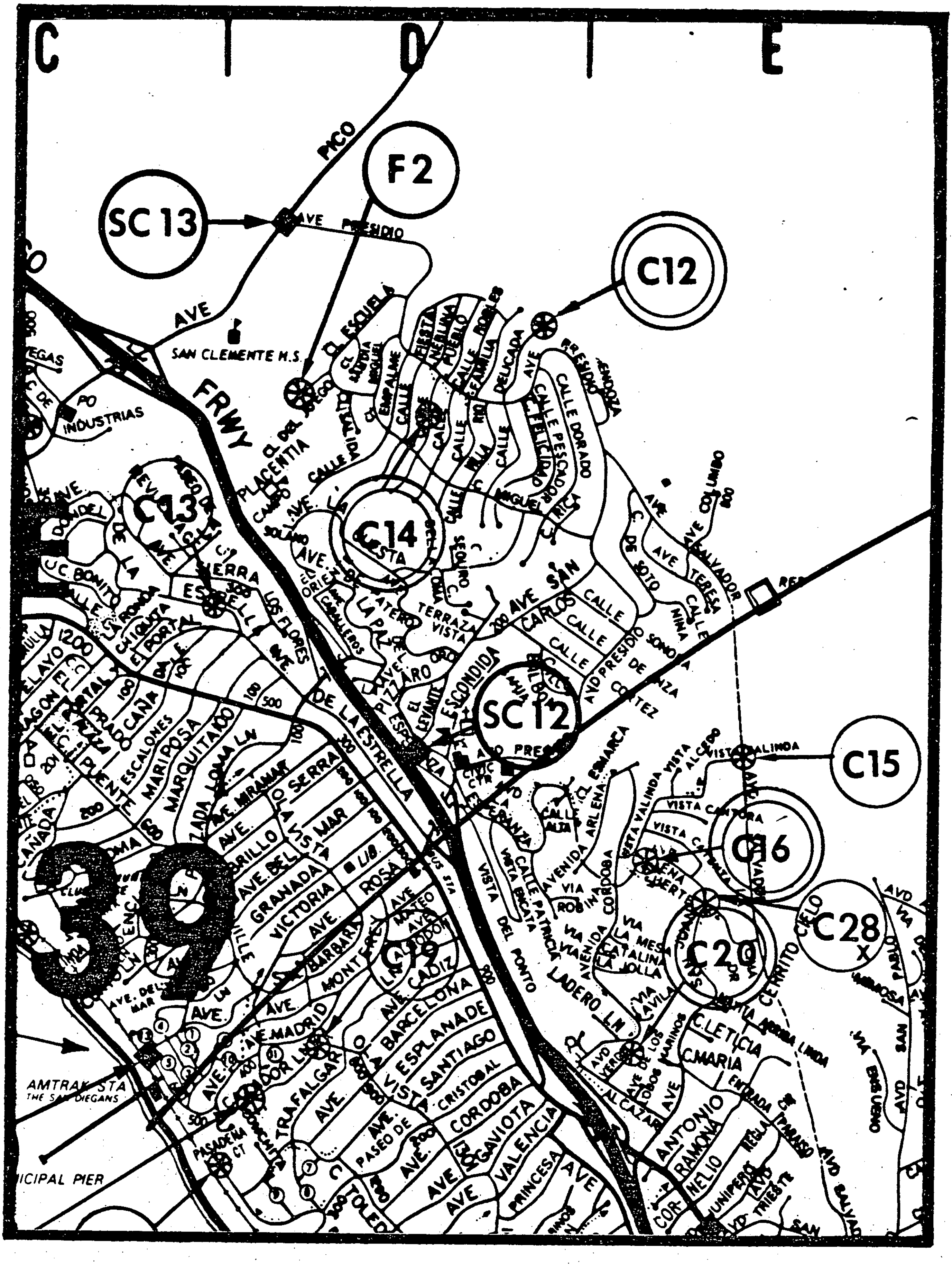

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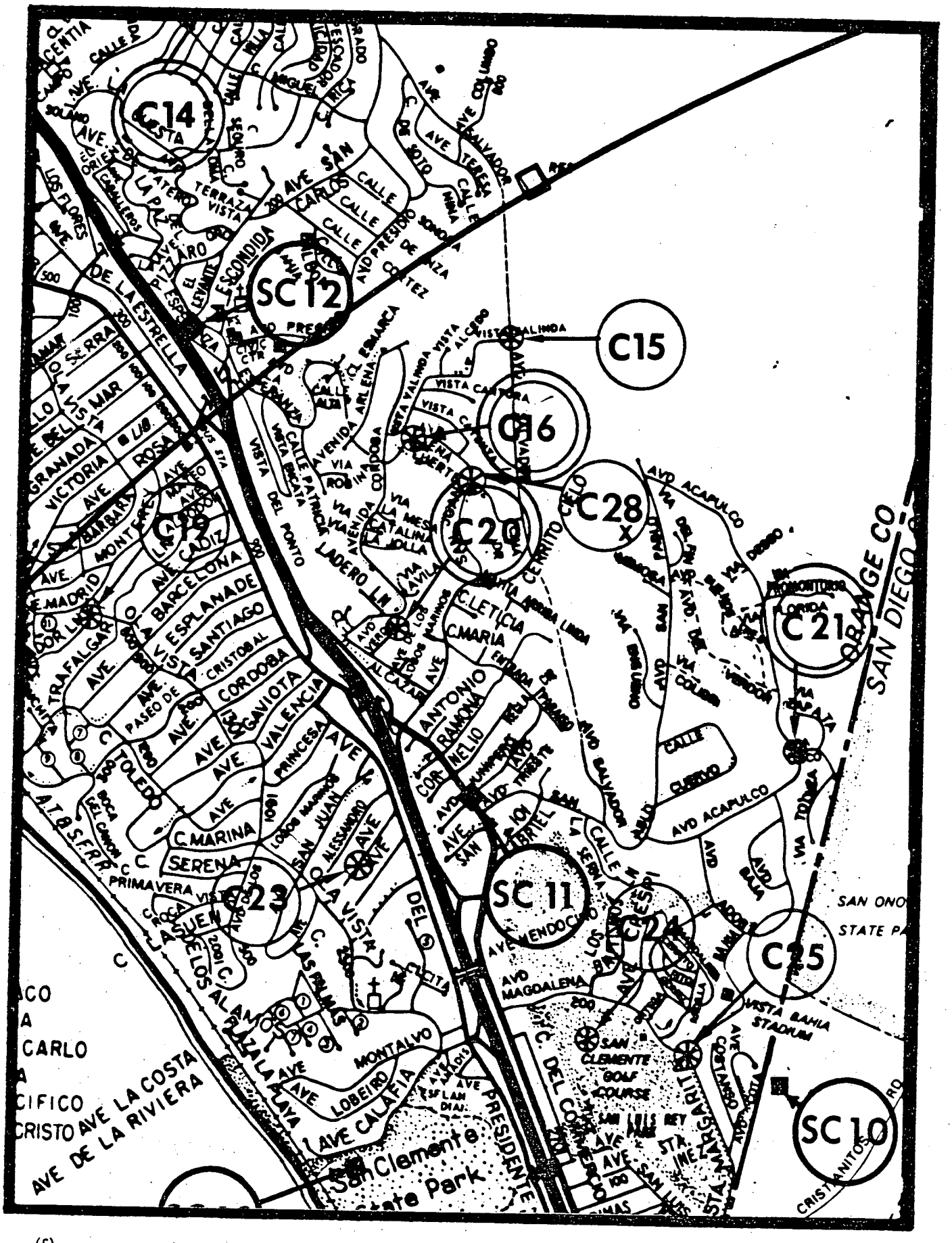

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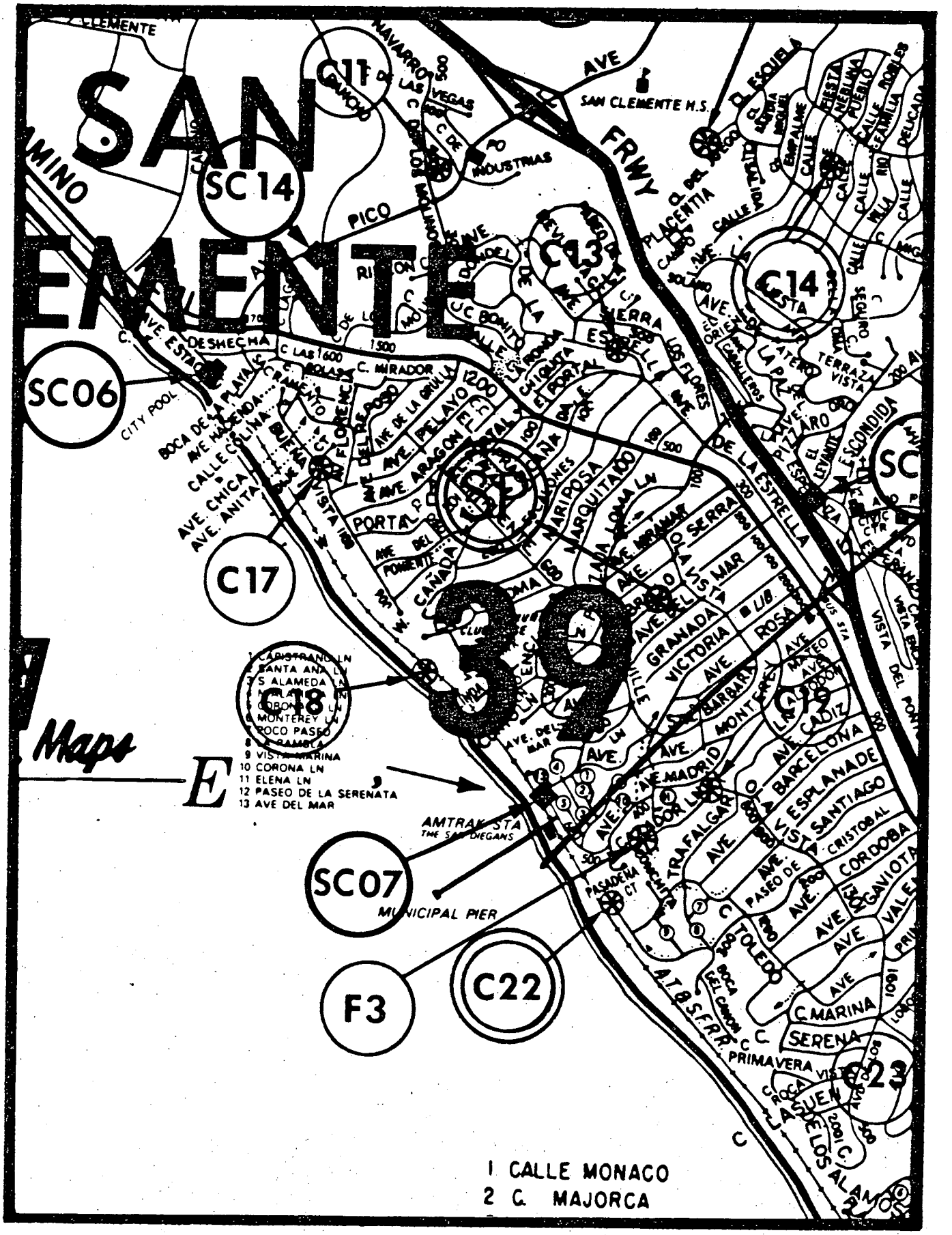

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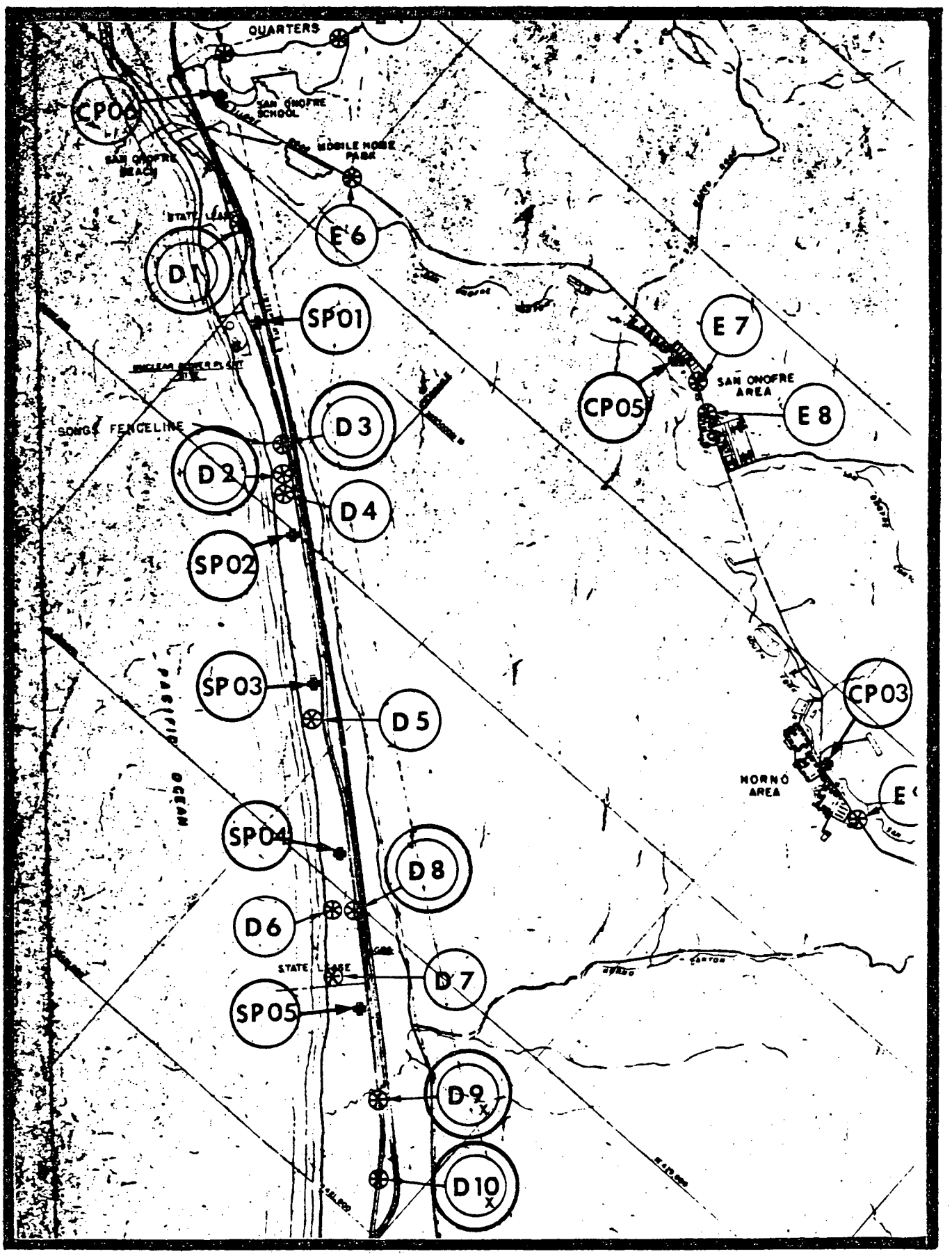

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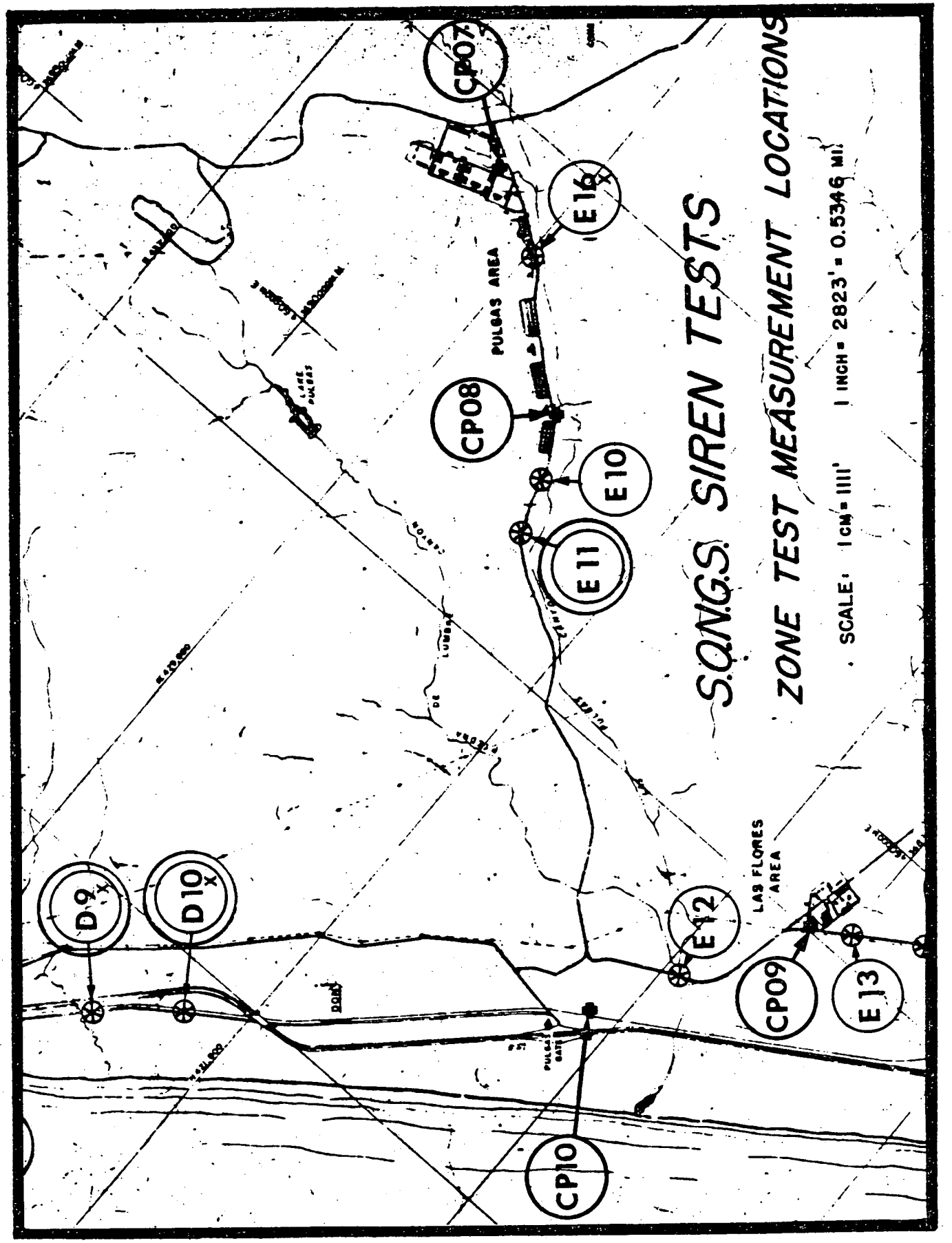

(i) Figure 2 (Continued)

Table 1

COMMUNITY SIREN SYSTEM 5/24/82 TEST

Measurement Location Descriptions by Team

Team 1

D2	On bluff midway between SONGS southeast corner and State Parks entrance booth
D3	Southeast corner of SONGS property on State Parks Rd., approx. 1,500 ft north of SP02
D8	Midway between SP04 and SP05 on State Parks Rd.
D9x	0.5 miles southeast of SP05 on State Parks Rd.
D10x	1.0 miles southeast of SP05 on State Parks Rd.

Team 2

A10x	At far west hairpin curve of Via Verde in Louise Leydon Park
B8	Corner of Camino Capistrano and Via Serra
B14x	100 ft south of freeway underpass around 33900 Camino Capistrano
B10x	On sidewalk by Golf Clubhouse on San Juan Creek Rd.
B11x	By large tree on first curve of Forster Ranch Rd. just off Valle Rd.

Team 3

A3	Mid-block on Via Lopez, between Via California and Via Sacramento
C2	At 3925 Via Manzana just off Calle Bienvenido
A9x	N. side of Calle Portola, 125 ft west of Calle Juanita
A4	Vacant lot on S. side of Calle Naranja, third lot NW of Calle Toba

Team 4

B6	NW corner of Via Cascada and Paseo de DeCora
B7	NE corner of Calle Borrego and Via Banderas
A12x	At bend between Calle Real and Paloma (in 34600 block of Paloma)
C4	At 842 Camino de Los Mares almost to Calle Nuevo

Team 5

C14	At 315 Calle Neblina - between Calle Miguel and Avenida Presidio
C12	100 ft south of cul-de-sac (at #425) on Calle Delicade
C16	Corner of Avenida la Esperanza and Avenida Buena Suerte
C20	At end of cul-de-sac (#115) Avenida Verde
C21	Corner of Avenida Acapulco and Via Cisco

Table 1 (Continued)

Team 6

C18	425 ft northwest of Linda Lane beach parking - beach side of railroad track
SP	On Ave Cabrillo between Palizada and Ole Vista
C22	At end of cul-de-sac on Trafalgar Court
E11	1.0 miles west of CP08
D1	3,200 ft north of SP01 on Basilone Road

Team 7

B5	Mid-block (#137) Caoba St
B13	Southernmost point of Forster Ranch Rd., where road turns northward into residential area

A - Orange County
B - San Juan Capistrano
C - San Clemente
D - State Parks
E - Camp Pendleton

2.3 Sound Measurement Procedures

Instrumentation

Precision Sound Level Meters complying with American National Standard ANSI S1.4-1971 (R1976), "Specifications for Type I Sound Level Meters," were employed at all sites for the measurement of ambient (background) noise levels and siren signal levels. In addition, these sound level meters were supplemented at selected sites by analog tape recording systems which comply with the requirements of ANSI S6.1-1973, "Qualifying a Sound Data Acquisition System."

Each item or system of measurement equipment was calibrated in accordance with the manufacturer's specifications. Field calibrations were performed prior to and after each test sequence by means of an acoustic calibrator. All analog recordings of sound pressure were preceded by an acoustic calibration signal identical to that used for field calibration of measurement equipment.

Personnel and Briefings

The acoustical measurements were performed by 29 engineering personnel. These personnel were distributed into seven teams, each of which was supervised by an engineer who was highly experienced in the acquisition of sound level data and who had detailed knowledge of the survey area and measurement sites.

Formal briefings and training sessions were held between 9 a.m. and 11:30 a.m. on May 24, 1982, to ensure that personnel were fully familiar with the requirements of the sound level data acquisition process using the particular type of instrumentation allocated to them. Dispersal to measurement sites commenced at 12:45 p.m. on the test day and all personnel were in place prior to siren activation.

Data Acquisition

Table 2 is a replica of "measurement procedures and test log section" sheets issued to each sound measurement engineer. Separate instruction sheets on system

operation, calibration procedures, and site locations were also issued to engineers as part of a Log Book. Each log book, together with instrumentation used in the survey, was inspected and/or tested for completeness and conformation with procedures at a debriefing session after the test.

The data acquisition procedures comprised four tasks, as follows:

Calibration: Each measurement system was calibrated at the measurement site by means of an acoustic calibrator.

Pretest Ambient Noise Measurement: A measurement was obtained of the typical ambient (background) noise level at the measurement site prior to siren activation. This measurement was performed to acquire information on the typical value of L_{90}, the sound level exceeded during 90 percent of the measurement time period.

Siren Signal Measurement: During the activation period of the siren, sound level data were acquired which provided information on the maximum and minimum sound levels (at the site) which were directly attributable to the siren signal. To minimize interference by wind noise, the siren levels were measured in terms of A-weighted levels, and subsequently corrected to C-weighted levels for this report.

Post-Test Ambient Noise Measurement: The procedure for measuring ambient (background) noise at the site was repeated after all siren signals were known to have ceased.

Table 2

COMMUNITY SIREN 5/24/82 TEST

Measurement Procedures

1. Calibrate microphones and record calibration data (at direction of Team Leader)
2. Arrive at site and verify correct location
3. Annotate tape (if using a recorder) and continue Log Section fill-in
4. Set up sound level meters or microphones on tripods (if provided)
5. Prepare for measurement
6. Contact TSC and inform them of readiness (via Team Leader)
7. Measure ambient noise while waiting for siren activation (2 p.m.)
8. Take siren data followed by post-test ambient noise reading
9. Complete Log Section entries including any informational notes
10. Wait for Team Leader pick-up
11. Pack equipment into vehicle
12. Return to Marina Inn for equipment turn-in and debriefing

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COMMUNITY SIREN 5/24/82 TEST LOG SECTION

Sound Level Meter Data

Test Engr: _____ Date: _____

Sound Level Meter

Type/Model #: _____ Set SLM to "Slow" response _____
Serial #: _____ Set SLM to "A" weighting _____

Calibrator

Type/Model/Serial #: ____/____/____ _____ dB at _____ kHz

TEST #1 Location #: _____ Time: _____ Battery OK? _____

Location Description: _____

MEASURED SOUND LEVELS

Ambient (pre-test)	Siren Sound Level	Ambient (post-test)
_____	Min _____ Max _____	_____

Comments: _____

3.0 TEST RESULTS

3.1 Typical Siren Signal Characteristics

Figures 3 and 4 show one-third octave band frequency spectra for short-term samples of the siren signals recorded at Locations A4 and C21, respectively. These spectra illustrate that the primary frequency content of the siren signals was in the 315 Hz and 400 Hz one-third octave bands, with minor harmonic levels at higher frequencies, and that the siren signals at these two locations were well in excess of noise levels in adjacent frequency bands.

Tables 3 and 4 show the statistical characteristics of the ambient noise and siren test signals at each of the two locations (A4 and C21). For Location A4, Table 3(a) shows the ambient noise statistics and Table 3(b) shows the siren signal data. Similarly, for Location C21, Table 4(a) shows the ambient noise characteristics and Table 4(b) shows the siren signal characteristics. In each of these tables, the L_0, L_1, L_{10}, etc., values are the sound pressure levels exceeded for 0 percent, 1 percent, 10 percent, etc., of the sample time period. These values are shown to be evaluated for each one-third octave band, for the overall A-weighted Sound Level, and for the overall Sound Pressure Level (Linear).

Examination of these tables shows that the siren signal levels at these two locations were well in excess of ambient background noise levels in the octave band containing the siren signal. (It should be noted that these short-term samples were extracted from the full record of the test. They are representative of, but do not necessarily agree exactly with, the test data submitted by the engineers for the complete test period.)

3.2 Summary of Measured Test Data

Table 5 is a compilation of all acoustic data acquired during the May 24, 1982, siren system test. Evaluation of the relationship between the Sound Level Meter data and the statistical values of (a) L_{10}, dB, for the siren signal level, and (b) the ambient noise level, L_{90}, dB, in the octave band containing the siren signal frequency, indicated that no corrections needed to be applied to the measured sound levels in compiling the Table 5 summary.

These metrics, L_{10} and L_{90}, are recognized indices of signal intrusiveness and ambient background noise level, respectively. These are consistent with research supporting FEMA Report CPG-1-17, "Outdoor Warning Systems Guide," as referred to in NUREG-0654.

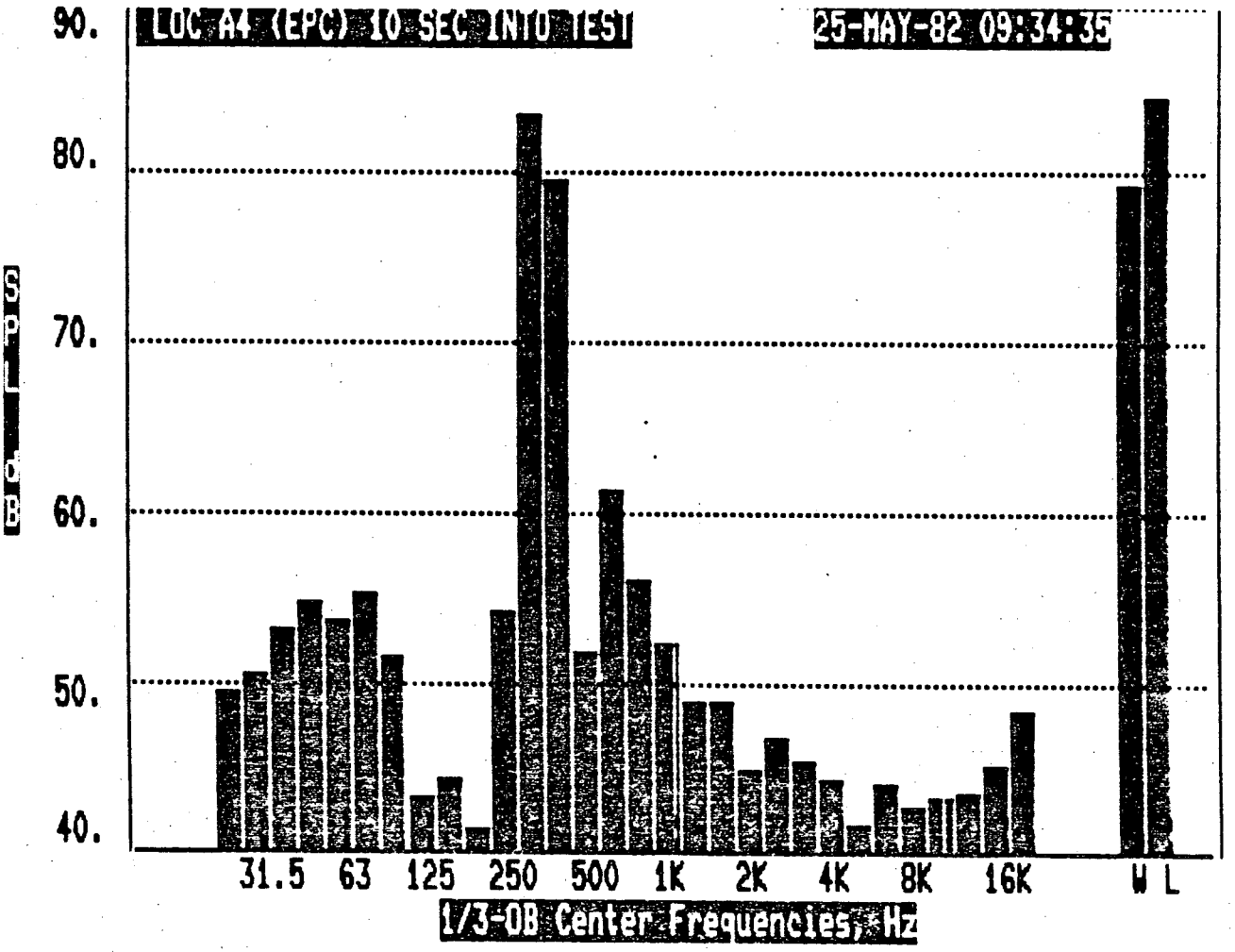

Figure 3. One-Third Octave Band Spectrum of Siren Signal Measured at Location A4 (24 May 1982)

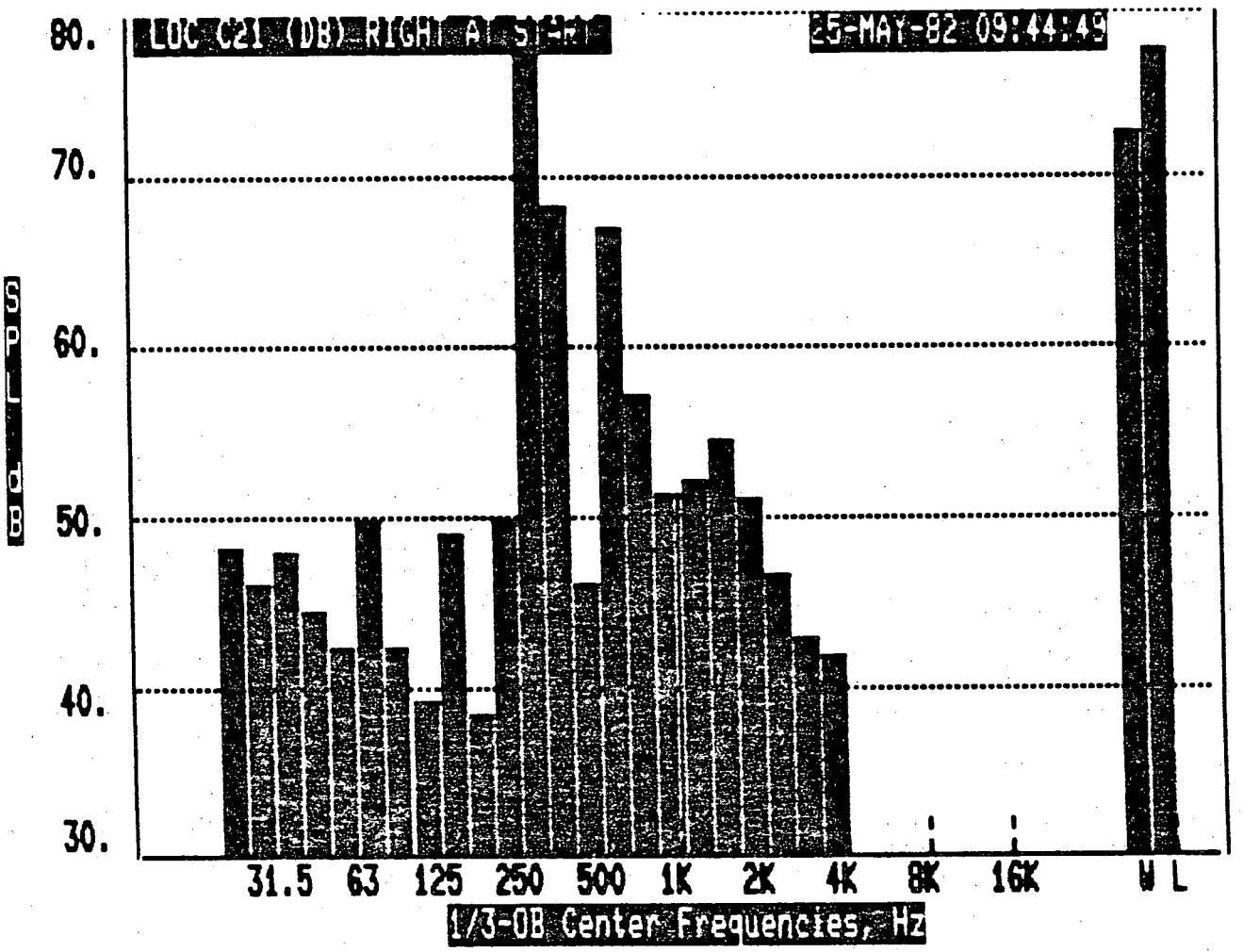

Figure 4. One-Third Octave Band Spectrum of Siren Signal Measured at Location C21 (24 May 1982)

Table 3(a)

Statistical Characteristics of Ambient Noise Recorded
at Location A4 (24 May 1982)

ZONE LOCATION A4 TYPE (S OR A) A

	Leq	L99	L90	L50	L10	L1	L0
Freq = 100	49.3	42.5	44.5	47.5	51.5	57.0	58.5
Freq = 125	43.9	39.0	40.0	42.5	46.0	49.5	50.0
Freq = 160	39.6	35.0	36.5	38.5	41.5	44.0	47.5
Freq = 200	39.1	33.0	35.0	38.0	41.0	45.0	45.5
Freq = 250	41.1	33.5	35.0	38.0	42.0	54.0	56.5
Freq = 315	41.3	35.5	36.5	39.0	43.5	51.0	53.5
Freq = 400	38.3	33.0	34.0	37.0	40.0	46.5	48.5
Freq = 500	38.5	34.0	35.5	37.5	40.5	42.5	44.0
Freq = 630	38.7	34.5	36.0	38.0	40.5	42.5	43.0
Freq = 800	38.9	35.5	36.0	37.5	41.5	43.5	44.0
Freq = 1000	40.8	36.5	37.5	39.5	43.5	46.5	47.0
Freq = 1250	37.3	34.0	34.5	36.0	39.5	41.5	42.0
Freq = 1600	34.8	31.5	32.5	34.0	36.0	41.5	42.0
Freq = 2000	34.4	31.0	32.0	33.0	35.0	43.5	44.0
Freq = 2500	36.5	30.0	31.0	34.0	39.0	44.5	45.0
Freq = 3150	38.5	30.0	31.5	37.0	41.5	44.5	47.0
Freq = 4000	39.3	30.5	32.0	37.5	43.0	45.5	46.5
Freq = 5000	35.3	30.0	31.0	33.0	38.0	43.5	44.0
Freq = 6300	32.1	31.0	31.0	31.5	32.5	34.0	34.5
Freq = 8000	32.0	31.5	31.5	31.5	32.0	33.5	35.0
Freq = 10000	32.8	32.0	32.0	32.5	33.0	33.0	33.5
"A" Weighted	50.2	46.5	47.5	49.0	52.0	54.5	55.0
Linear	59.4	55.0	56.5	58.5	61.0	64.5	65.5

Table 3(b)

Statistical Characteristics of Sound Level Data
Recorded at Location A4 During Siren Test
(24 May 1982)

ZONE LOCATION A4 TYPE (S OR A) S

	Leq	L99	L90	L50	L10	L1	L0
Freq = 100	52.1	45.0	46.0	48.5	55.5	61.0	62.0
Freq = 125	51.4	42.0	45.0	49.0	55.0	59.0	59.5
Freq = 160	60.4	48.0	50.5	59.0	64.0	68.5	69.0
Freq = 200	51.2	40.5	42.5	45.5	52.5	62.0	64.5
Freq = 250	47.3	40.5	41.5	45.5	50.0	53.0	54.0
Freq = 315	73.9	63.5	66.0	72.5	77.0	78.0	78.5
Freq = 400	72.8	62.0	64.5	71.5	76.0	77.0	77.5
Freq = 500	48.8	41.0	43.0	46.0	50.5	61.0	61.5
Freq = 630	60.6	45.5	49.5	57.0	64.5	71.0	71.5
Freq = 800	60.2	44.0	48.5	56.5	65.0	67.5	68.0
Freq = 1000	51.5	40.5	43.5	49.5	54.5	58.5	62.0
Freq = 1250	48.1	40.5	43.5	47.0	50.0	56.5	57.5
Freq = 1600	48.2	41.0	43.0	47.0	50.5	57.0	57.5
Freq = 2000	45.8	40.5	40.5	43.5	49.0	53.0	54.0
Freq = 2500	44.3	40.5	40.5	42.5	47.0	51.0	51.5
Freq = 3150	44.9	40.5	40.5	42.0	49.0	52.0	53.5
Freq = 4000	44.1	40.5	40.5	42.0	47.5	50.0	51.0
Freq = 5000	42.3	40.5	40.5	41.0	45.0	47.0	47.0
Freq = 6300	42.9	42.0	42.0	42.5	44.0	46.5	46.5
Freq = 8000	41.7	41.0	41.0	41.5	42.0	44.5	44.5
Freq = 10000	42.2	41.5	41.5	42.0	42.5	43.5	46.0
"A" Weighted	72.3	63.0	67.0	71.5	75.0	76.0	76.5
Linear	77.8	70.0	73.0	76.5	80.5	81.5	82.0

Table 4(a)

Statistical Characteristics of Ambient Noise
Recorded at Location C21
(24 May 1982)

ZONE LOCATION C21 TYPE (S OR A) A

	Leq	L99	L90	L50	L10	L1	L0
Freq = 100	46.8	36.5	41.0	45.5	49.0	55.0	55.5
Freq = 125	40.9	31.5	33.0	38.5	44.0	48.0	52.5
Freq = 160	44.3	33.0	35.0	43.5	46.0	52.5	54.0
Freq = 200	42.4	29.0	31.5	39.0	46.0	51.0	52.0
Freq = 250	38.3	27.0	29.0	34.5	41.0	48.0	52.5
Freq = 315	39.0	26.0	28.0	34.0	42.5	50.5	51.5
Freq = 400	35.8	23.0	24.5	30.0	39.5	46.0	46.5
Freq = 500	35.4	21.5	24.0	30.5	39.5	46.5	48.0
Freq = 630	34.5	22.5	24.0	30.5	38.0	44.5	48.5
Freq = 800	34.8	22.0	23.5	30.0	38.0	44.0	49.0
Freq = 1000	37.7	21.5	23.5	36.0	41.5	47.0	48.0
Freq = 1250	35.2	23.0	24.5	32.0	38.5	45.0	47.0
Freq = 1600	34.5	20.5	22.0	31.5	38.0	44.5	47.5
Freq = 2000	35.0	20.5	22.0	32.0	37.5	45.5	46.0
Freq = 2500	35.4	20.5	23.0	33.5	37.0	46.0	46.5
Freq = 3150	34.9	20.5	22.0	34.5	37.0	43.5	44.0
Freq = 4000	35.5	20.5	24.0	35.0	37.5	43.0	44.0
Freq = 5000	36.3	20.5	24.5	36.0	38.5	43.0	44.0
Freq = 6300	33.8	21.0	21.5	32.0	36.5	41.0	42.0
Freq = 8000	31.2	20.5	22.0	31.0	33.0	37.0	40.5
Freq = 10000	28.2	20.5	20.5	28.0	30.5	33.0	34.0
'A' Weighted	47.9	35.5	37.0	46.5	50.0	57.5	59.0
Linear	61.2	51.0	53.0	59.0	63.0	70.0	70.0

Table 4(b)

Statistical Characteristics of Siren Sound Level Data
Recorded at Location C21 During Siren Test
(24 May 1982)

ZONE LOCATION C21 TYPE (S OR A) S

	Leq	L99	L90	L50	L10	L1	L0
Freq = 100	47.6	35.0	38.5	44.0	51.0	55.5	56.0
Freq = 125	50.3	31.0	35.0	42.5	52.0	64.5	65.0
Freq = 160	57.3	31.5	34.0	44.5	52.5	72.0	72.5
Freq = 200	45.9	30.5	33.0	40.5	49.5	55.5	56.0
Freq = 250	45.0	33.0	36.0	42.5	48.5	52.0	53.0
Freq = 315	69.0	56.0	59.5	66.0	72.5	77.5	78.0
Freq = 400	60.4	49.0	52.5	58.0	64.0	68.0	68.5
Freq = 500	42.3	30.5	33.5	41.0	45.5	48.0	48.5
Freq = 630	58.6	44.5	49.0	55.5	62.0	68.0	68.5
Freq = 800	50.1	40.0	43.0	47.5	53.5	58.5	59.0
Freq = 1000	50.4	37.0	40.5	46.0	53.0	60.5	61.0
Freq = 1250	48.1	34.5	38.5	46.0	51.5	56.5	57.0
Freq = 1600	45.5	33.5	37.0	42.5	48.0	55.0	55.5
Freq = 2000	44.7	32.5	36.0	41.5	48.5	53.0	53.5
Freq = 2500	44.1	33.5	37.5	42.0	47.0	53.0	54.0
Freq = 3150	41.2	31.0	34.0	39.0	44.5	48.5	50.5
Freq = 4000	37.1	30.5	31.0	35.5	40.0	42.5	44.0
Freq = 5000	36.0	30.5	31.0	34.5	39.0	40.5	41.0
Freq = 6300	37.4	30.5	31.5	35.5	40.5	45.0	45.0
Freq = 8000	34.4	30.5	30.5	32.5	38.0	39.5	39.5
Freq = 10000	32.6	30.5	30.5	31.5	34.0	34.5	34.5
"A" Weighted	65.4	56.0	58.5	63.0	68.0	73.5	74.0
Linear	71.8	63.5	65.0	70.5	74.5	78.5	79.0

Table 5

Summary of Siren Test Data (24 May 1982)

Site Location	Siren Signal Level, L_{10}, dB(C)	Ambient Noise Level, L_{90}, dB	Signal-to-Noise Ratio, dB
A3	75	58	17
A4	78	47	31
A9	78	56	22
A10	82	49	33
A12	77	57	20
B5	61	44	17
B6	75	46	29
B7	75	38	37
B8	80	49	31
B10	62	56	6
B11	Audible	62	—
B13	69	45	24
B14	88	68	20
C2	70	44	26
C4	60	56	4
C12	61	38	23
C14	57	39	18
C16	65	39	26
C18	75	57	18
C20	56	51	5
C21	74	34	40
C22	64	53	11
D1	72	57	15
D2	68	56	12
D3	68	56	12
D8	Measurement System Fault		
D9	67	49	18
D10	61	46	15
E11	42	39	3

3.3 Review of Test Results

Of the 29 measurement locations allocated for purposes of the May 24, 1982, test, acoustic data were acquired at all but one of these sites. The following information relates to these 28 sites:

Total number of measurement locations	28
Locations where signal levels exceeded 60 dB(C)	24
Locations where the signal-to-noise ratio exceeded 10 dB	23
Locations where signal levels exceeded 60 dB(C) and signal-to-noise ratio exceeded 10 dB	22

Combining these test results with those acquired during tests of the siren system during January 25-29, 1982, provides the following overall assessment:

Total number of measurement locations	81
Locations where signal levels exceeded 60 dB(C) and the signal-to-noise ratio exceeded 10 dB	70

This indicates that the currently installed system meets the signal level and signal-to-noise criteria at 86 percent of the randomly selected measurement locations.