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June 5, 1992

HAND DELIVERED

Ms. Donna R. Searcy, Secretary
Federal Communications Commission
Washington, D.C. 20554

RECEIVED

JUN - 5 1992

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Re: Echo Group L.P.
Request for Pioneer's Preference
File No. PP-36,
ET Docket No. 92-100

Dear Ms. Searcy:

Attached please find for filing the original and five (5) copies of appendices related to the Pioneer's Preference Request of Echo Group L.P., ET Docket No. 92-100, PP-36. Echo had previously filed these appendices on June 1, 1992 as part of its technical feasibility showing with a request for confidential treatment pursuant to Section 0.459 of the Commission's rules. However, in a letter dated June 3, 1992 from Thomas P. Stanley, that confidentiality request was denied and the appendices returned. Therefore, Echo herein submits the appendices for filing.

If there are any questions regarding this matter, please contact the undersigned.

Sincerely,

Jay L. Birnbaum
Counsel for Echo Group L.P.

Attachment

cc: Attached service list

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APPENDIX I

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E X E C U T I V E S U M M A R Y

The Cellular Data Inc. (CDI) data communications system transmits 2kb/sec data channels between central transponders located at normal cellular telephone base stations and low-cost user units located around the cell site. The CDI transponder is located 15 kHz away from the normal voice channels in the cellular base station. A series of field tests were conducted to test the interference to the cellular service that may be caused by the CDI transmissions.

A wide series of tests were carried out to determine the limitations that must be imposed on the CDI transmissions to ensure that the cellular users receive no interference. The conclusions were:

a) For transmissions from the base stations, the CDI signal must maintain its signal level 25dB below the signal level of the adjacent cellular voice channel. This limit is satisfactory if the CDI transmissions use an antenna with the same radiation pattern, but located at a few feet or more from the cellular transmit antenna.

b) For transmissions from the base station the CDI signal may use a signal level 20dB below the signal level of the adjacent cellular voice channel if the two signals are transmitted from the same antenna.

c) For transmissions from the base station, the CDI signal may use a signal level 20dB below the signal level of the adjacent cellular voice channel if the CDI signal uses a horizontally polarized antenna. Care must be taken to ensure that the horizontal antenna has a similar beam shape in the region from horizontal to about 40 below horizontal.

d) Use of horizontal polarization on the CDI base station transmissions gives approximately 11dB additional isolation for the CDI user receivers, protecting them from the cellular voice channels.

e) For transmissions from the CDI user transponders to the base station, the CDI receiver uses the antenna and distribution amplifier used by the cellular voice channel. The CDI signal must be controlled to keep their carrier-to-noise (C/N) equal to 20dB in their 3kHz receiver bandwidth. If this is done no interference results on the adjacent cellular voice channel.

f) Tests showed that the above limitations to CDI transmissions in the reference cell eliminated any interference in the adjacent channel cell (normally located at least two cells away from the reference cell.)

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g) Tests showed that the above limitations to CDI transmissions in the reference cell eliminated any interference in the co-channel reuse cell (normally located at least three cells away from the reference cell.)

The tests confirmed that, with the limitations stated above, the CDI system can operate in a normal cellular system without interference.

5/19/89
Date

Bruce Lusignan
Bruce B. Lusignan
President
TransTech International

FREQUENCY COORDINATION TESTS

(CDI)

TABLE OF CONTENTS

I. OVERVIEW

II. THE TEST SITE

III. INTERFERENCE TEST EQUIPMENT

IV. TAPE RECORDS

V. OUTBOUND REFERENCE CELL TESTS

VI. INBOUND REFERENCE CELL TESTS

VII. CO-CHANNEL REUSE TESTS

VIII. ADJACENT CHANNEL TESTS

IX. CROSS POLARIZATION TESTS

APPENDIX A: TAPE LOGS

APPENDIX B: CROSS POLARIZATION MEASUREMENTS

X. USER UNIT FIELD TEST

II THE TEST SITE

The San Diego area was used for the tests. This area is served by Pac-Tel Cellular. There are 21 base sites active at this time with a fairly rich frequency Re-use pattern. Figure 3 shows the locations of the base sites on the map. (The area is the SouthWest corner of California extending down to the Mexican border.) Each circle represents a cellular base site. The circles with triangles are sectored base sites; towers with antennas pointing to three separate areas for coverage of three cells. In frequency coordination strategy, these are known as "edge-fed" cells. The numbers correspond to the frequency groups assigned to each cell site.

Figure 4 shows the terrain of the San Diego area. To the East, the hills provide a complex coverage problem. Along the coast the terrain is more flat. Figure 5 shows the coverage pattern of the cells used in the tests.

The patterns are defined using the radio facility planning program developed at Stanford (REF 1) and adopted by TTI to CDI's needs. The terrain shown on Figure 4 is used along with the tower height and antenna specifications provided by Pac-Tel Cellular. The coverage is based on the Longley-Rice propagation models and prove to be quite accurate. The coverage pattern shown in Figure 5 is obviously more complicated than the simple sketch of hexagons due to terrain and other "real-world" features.

In the first set of tests, the CDI transmissions were made from the Mission Valley Base Station, $\pm$ 15kHz away from a Mission Valley cellular telephone channel. The cell coverage pattern is shown in Figure 6. The mobile was run throughout this coverage area testing for interference from the CDI transmission in the reference cell.

The second tests were made with the CDI transmissions from Mission Valley with the mobile being served by the Adjacent Channel cell. There are several cells in the San Diego area with channels adjacent to the Mission Valley assignment. The closest, Sorrento Valley, was used as the Adjacent Channel cell, Figure 7.

The third tests were made with the CDI transmissions from Mission Valley with the mobile being served by the Re-use cell in Carlsbad site, Figure 8.

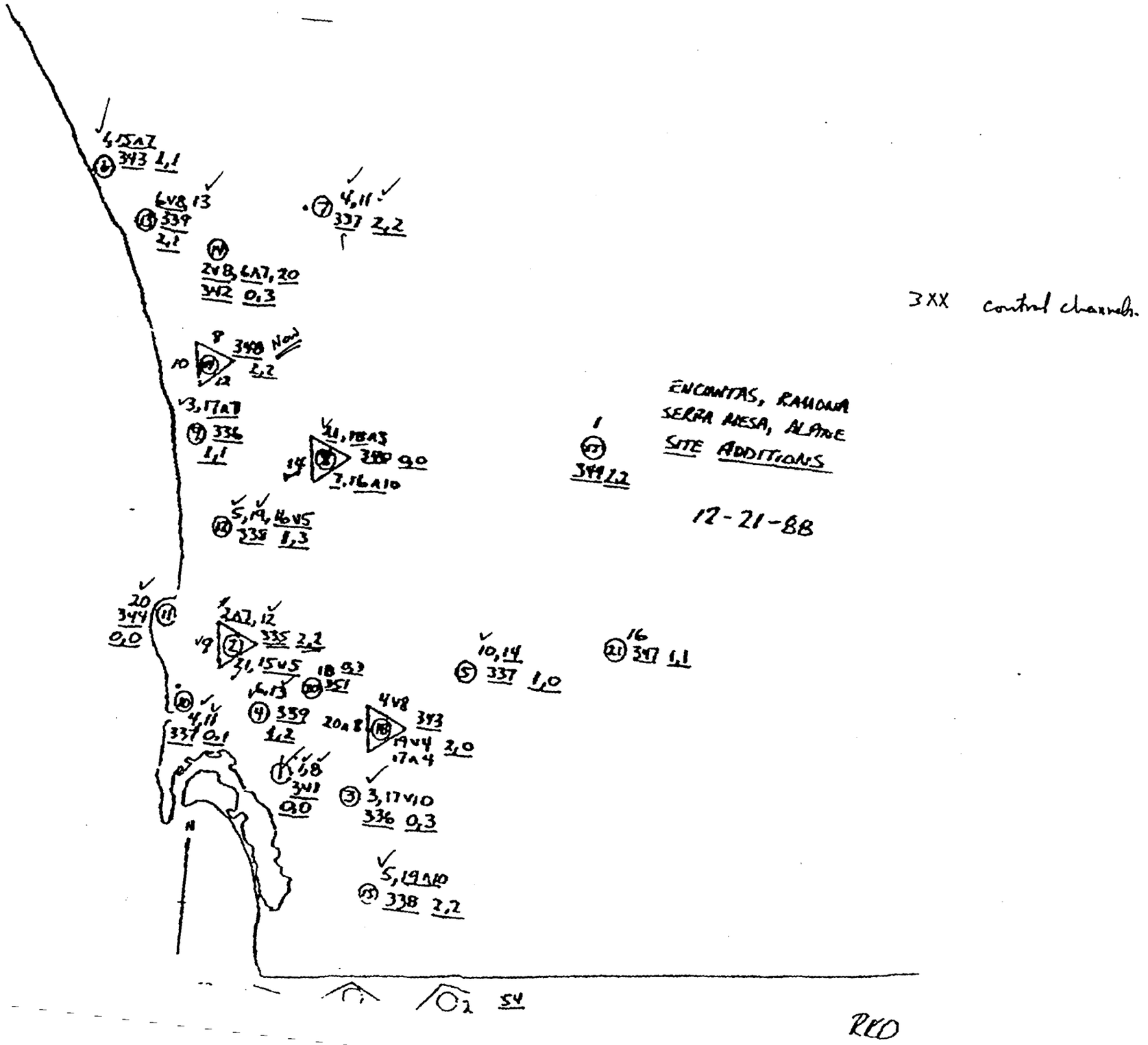
All the Outbound tests, Base Station transmitting to the CDI User Transponder, were done from the Mission Valley site. This site allowed easy access to the antenna platform and, thus, different CDI antennas could be tested.

For Inbound tests, CDI User Transponder transmitting to the Base Station, the Mt. Ada Base Station was used. This cell has a larger area coverage. There is more possibility that mobile will requiring service at low signal strength. This offers more stringent coordination conditions than offered by the Mission Valley site. The tests were moved to Mt. Ada for that reason.

The Mt. Ada site has an omnidirectional antenna for some of its channels and three different sectored antennas for three additional groups. The patterns are shown in Figures 9, 10, 11 and 12.

The adjacent-channel site for the Mt. Ada tests was Solano Beach, Figure 13. The Re-use site for Mt. Ada tests was Squires Dam. Figure 14.

FIGURE 3


3XX control channels.
ENCANTAS, RAMONA
SERRA MESA, ALPINE
SITE ADDITIONS
12-21-88
N
RED

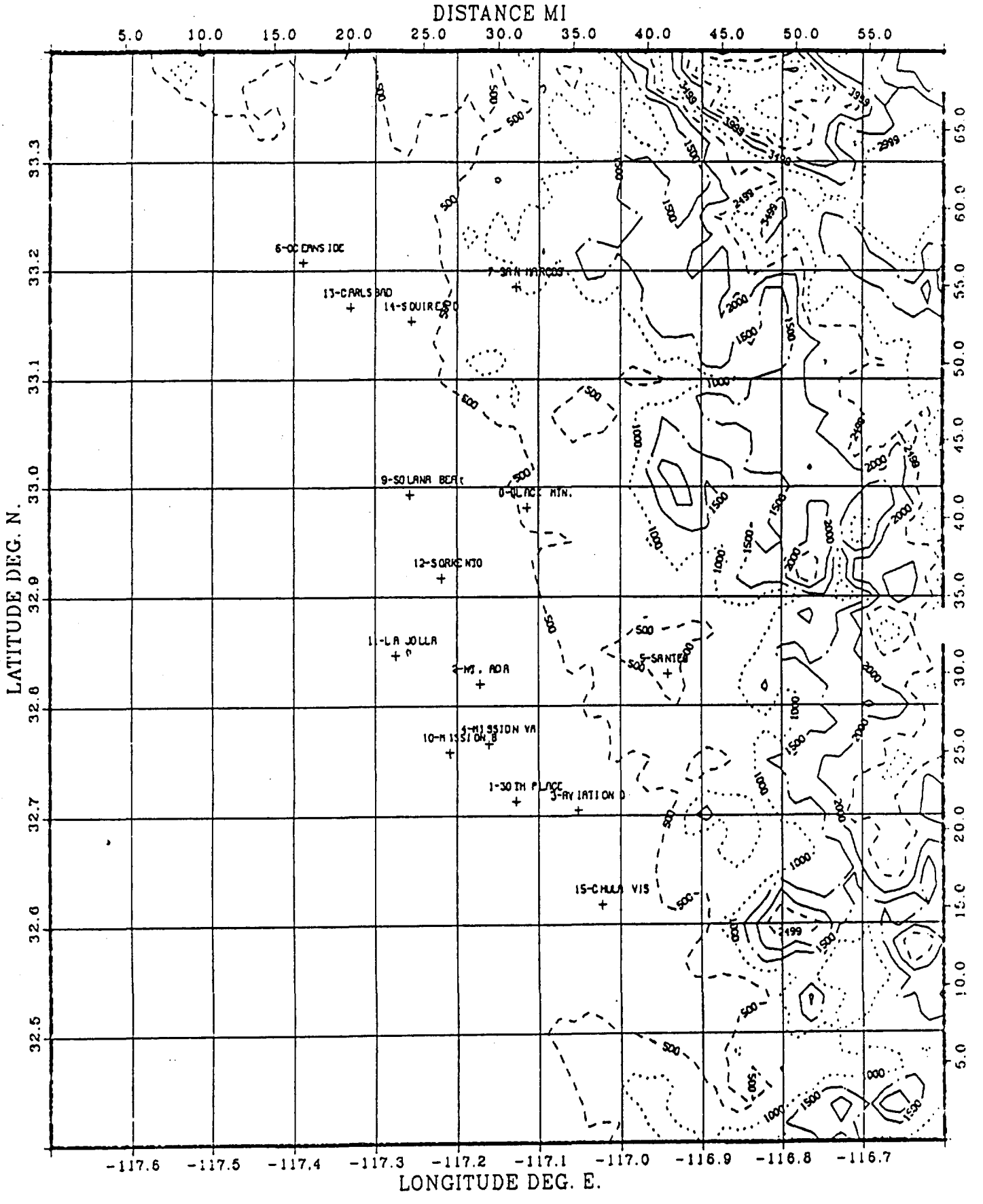


FIGURE 4 - Elevation contours

39 dBUV/M Coverage Areas of Base Sites with
Co-ch. Groups: 040,110 and Adj. Ch. Groups: 030,050,120

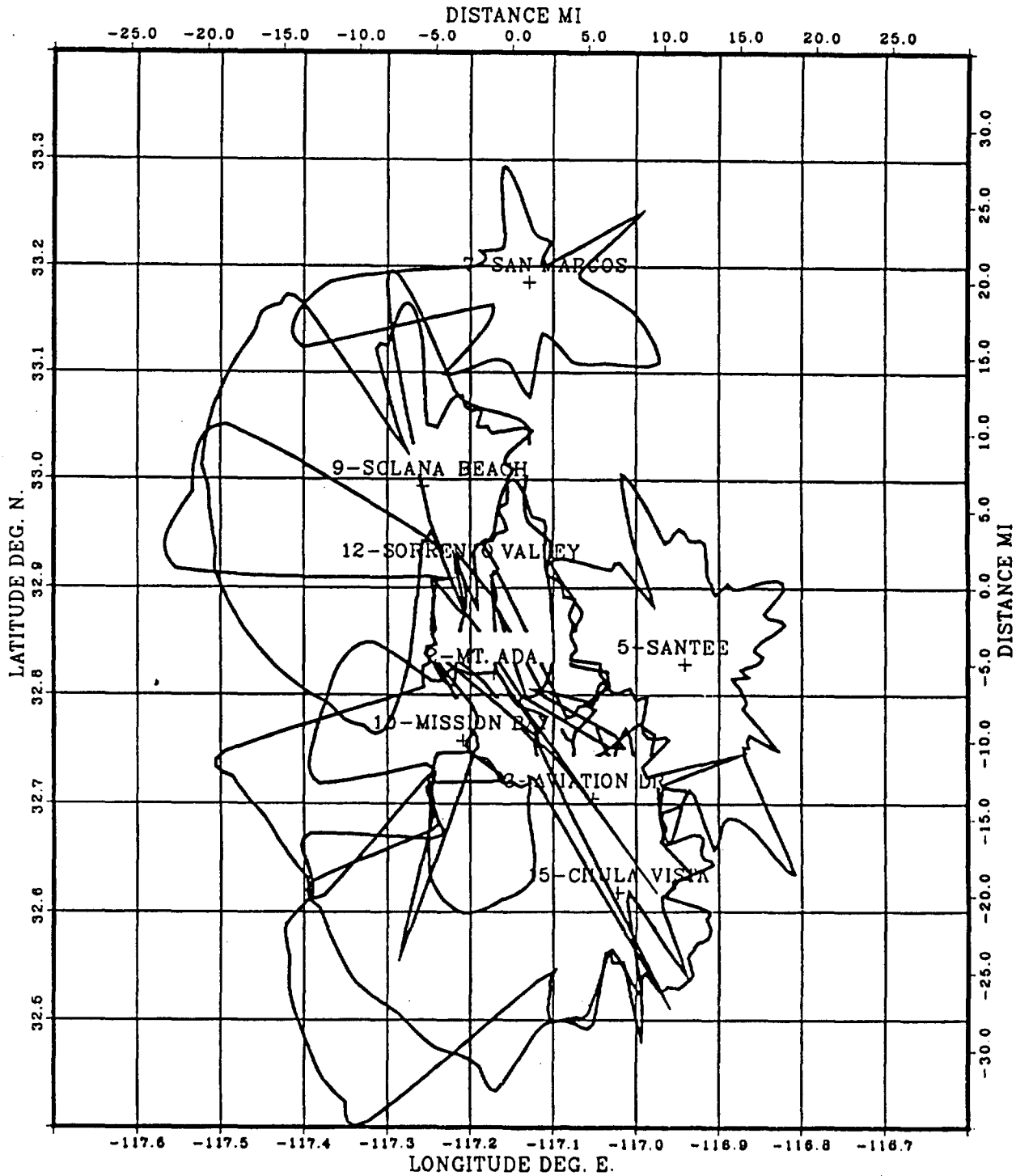


FIGURE 5

39 dBUV/M Coverage Area of Base Site 4-MISSION VALLEY
Channel Groups: 060, 130

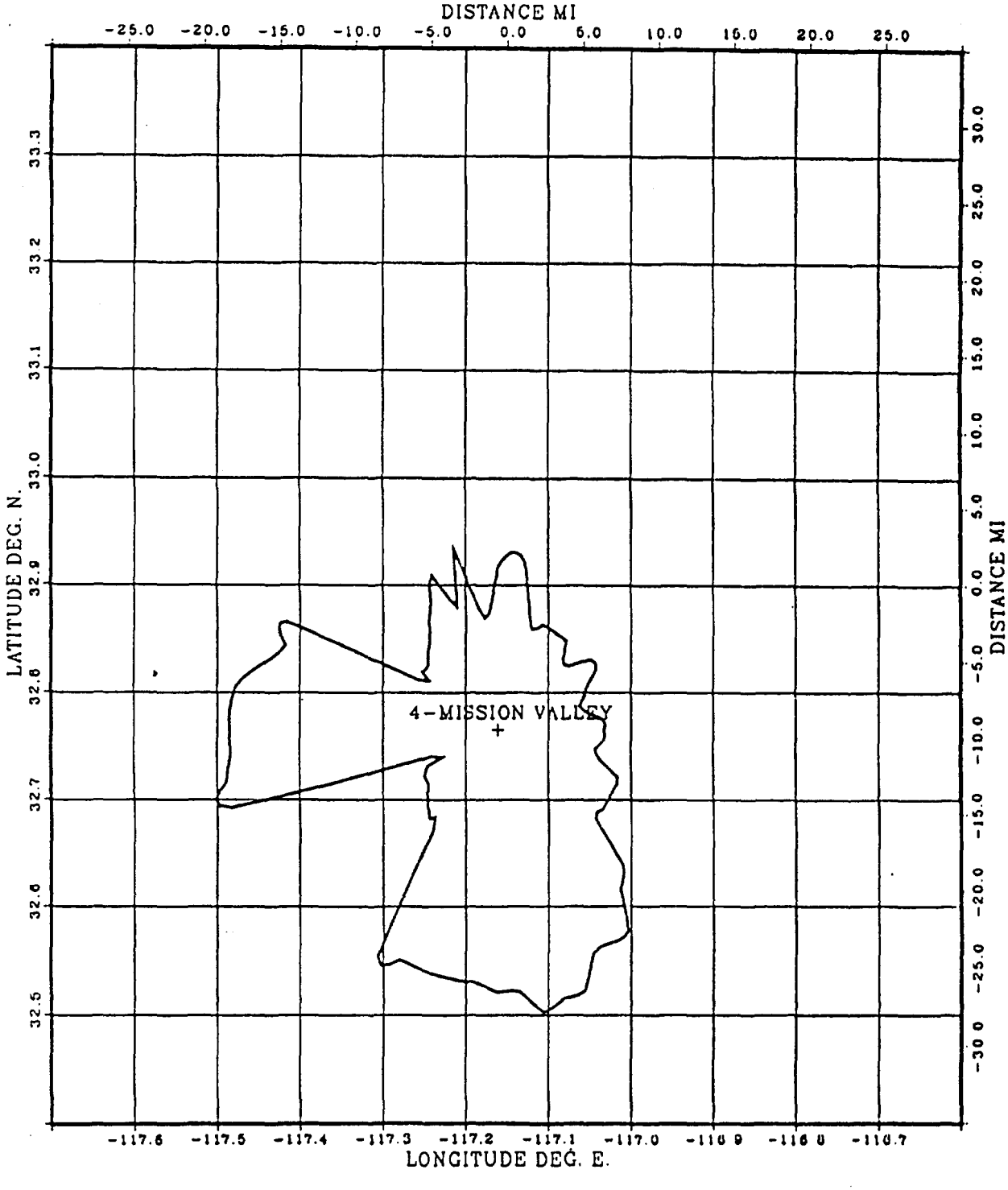


FIGURE 6 - Mission Valley coverage

39 dBUV/M Coverage Area of Base Site 4-MISSION VALLEY
Channel Groups: 060, 130

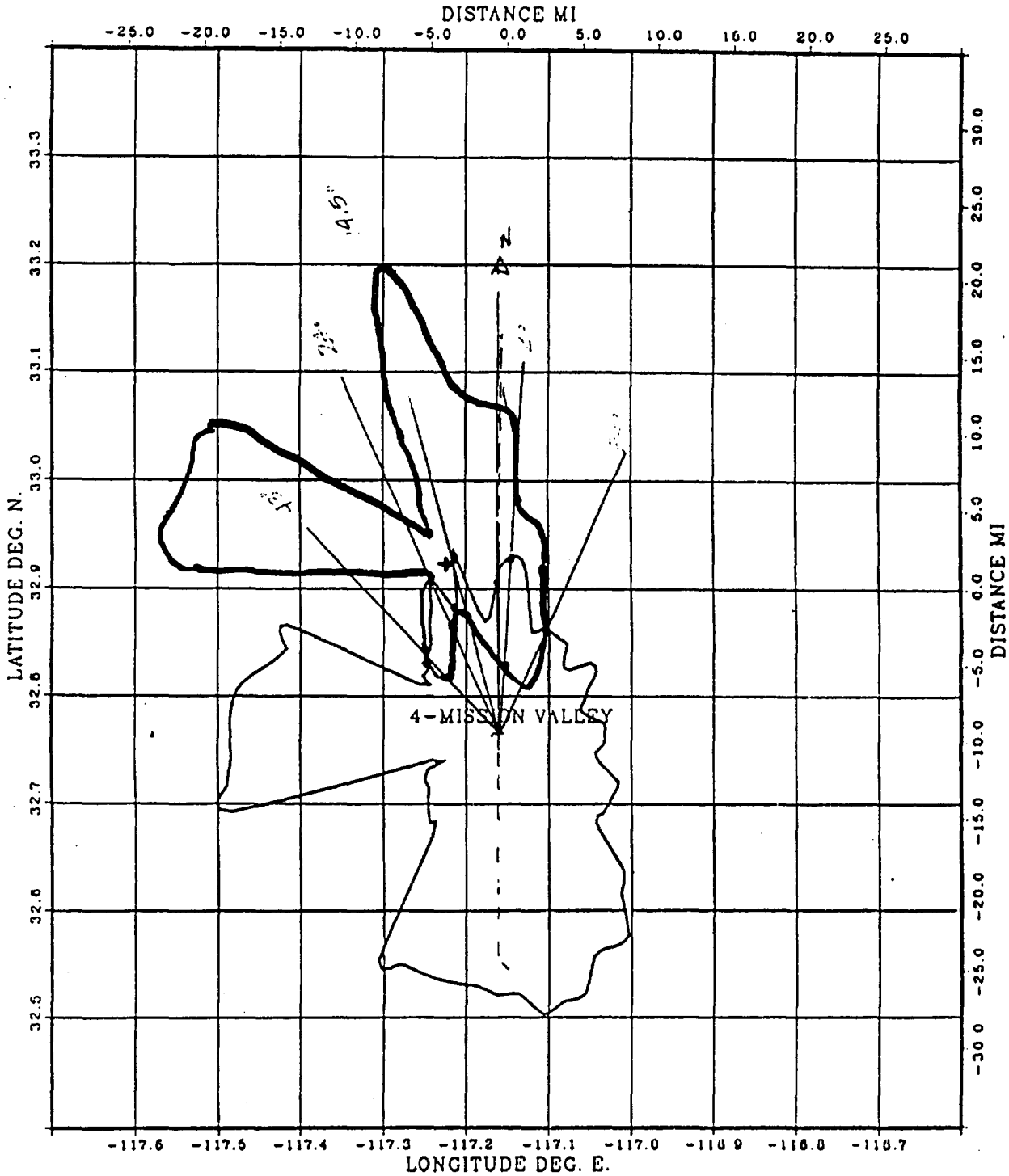


FIGURE 7 - Sorento Valley Contour
Adjacent Channel Cells

39 dBUV/M Coverage Area of Base Site 13-CARLSBAD
Channel Groups: 060, 130

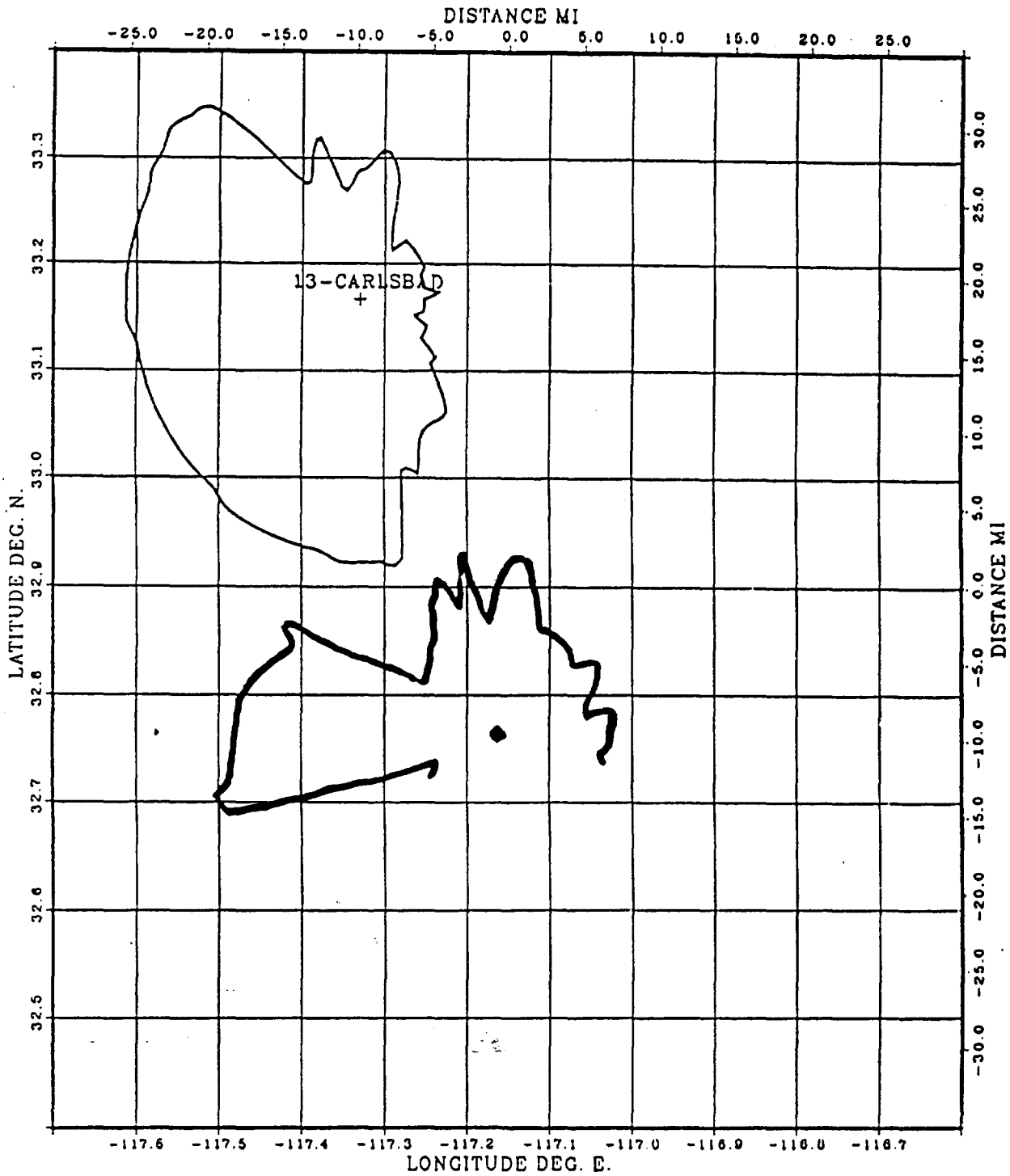


FIGURE 8 - Mission Valley
Reuse Frequency Cells

39 dBUV/M Coverage Area of Base Site 2-MT. ADA
Channel Groups: 020, 090, 120, 152, 210

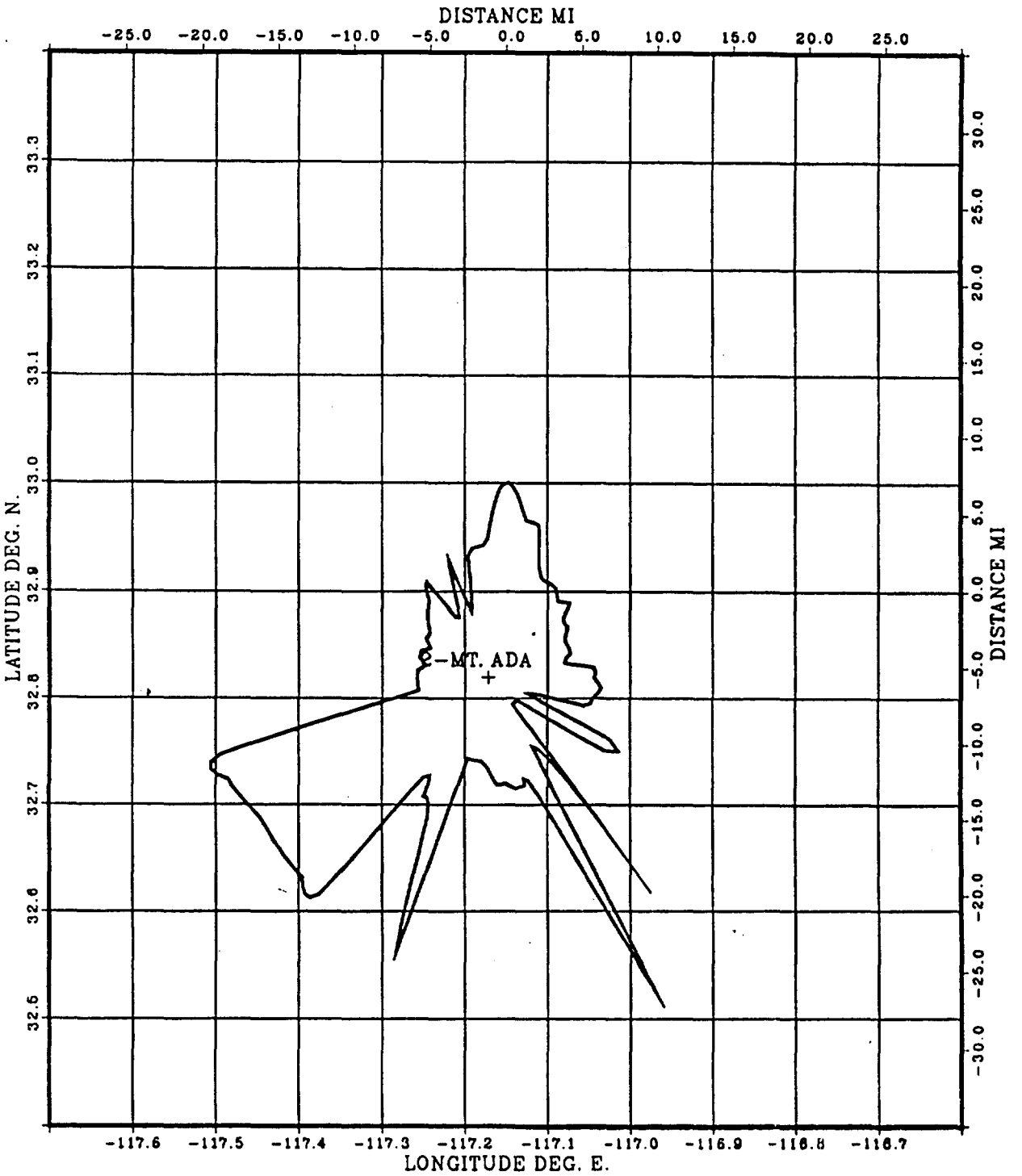


FIGURE 9

39 dBUV/M Coverage Area of Base Site 2-MT ADA Using
Sector Antenna at (16 deg. CW from N.). Ch.G: 2~7,12

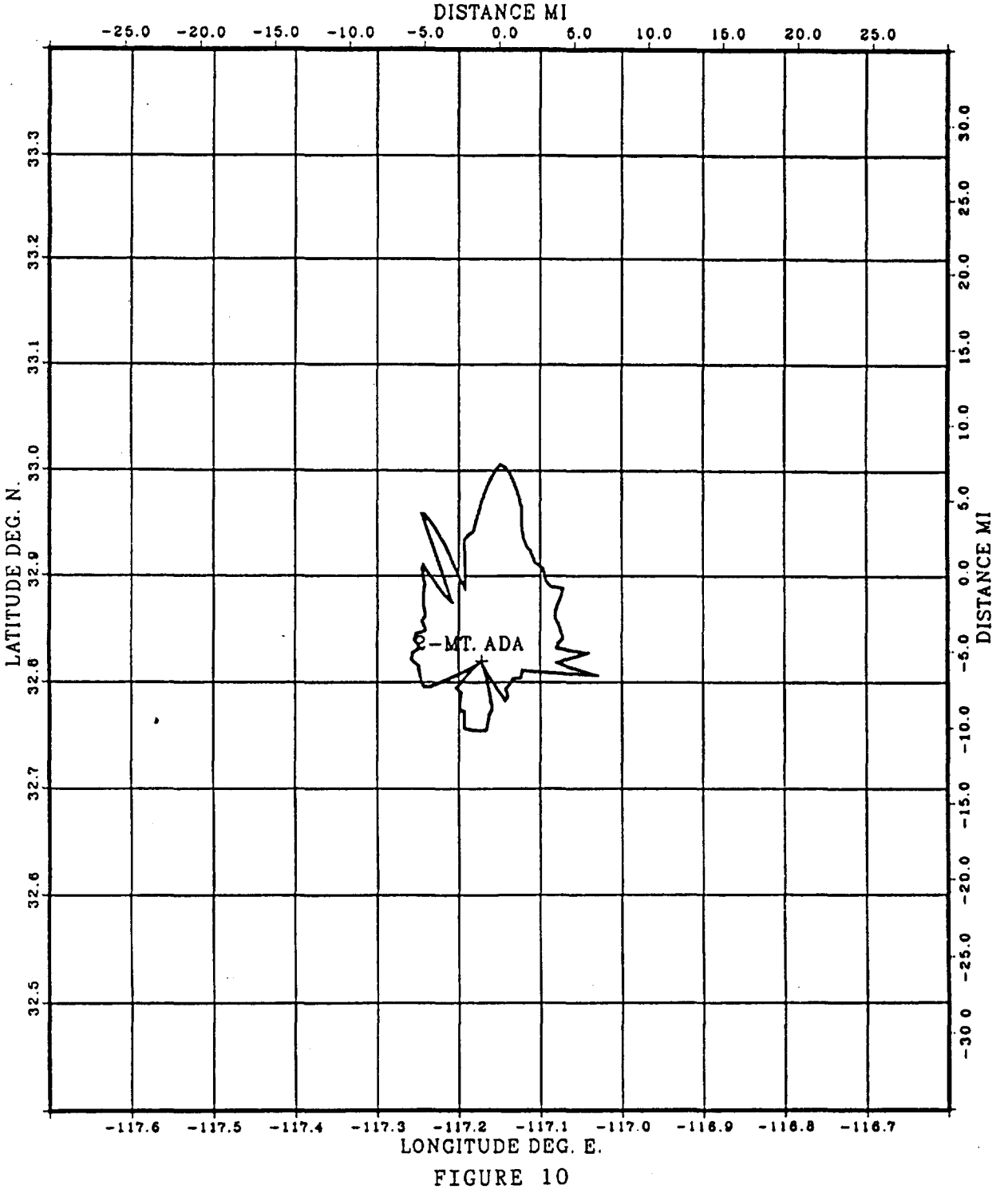


FIGURE 10

39 dBUV/M Coverage area of Base Site 2-MT ADA Using
Sector Antenna at (136 deg. CW from N.), Ch.G: 21.15v5

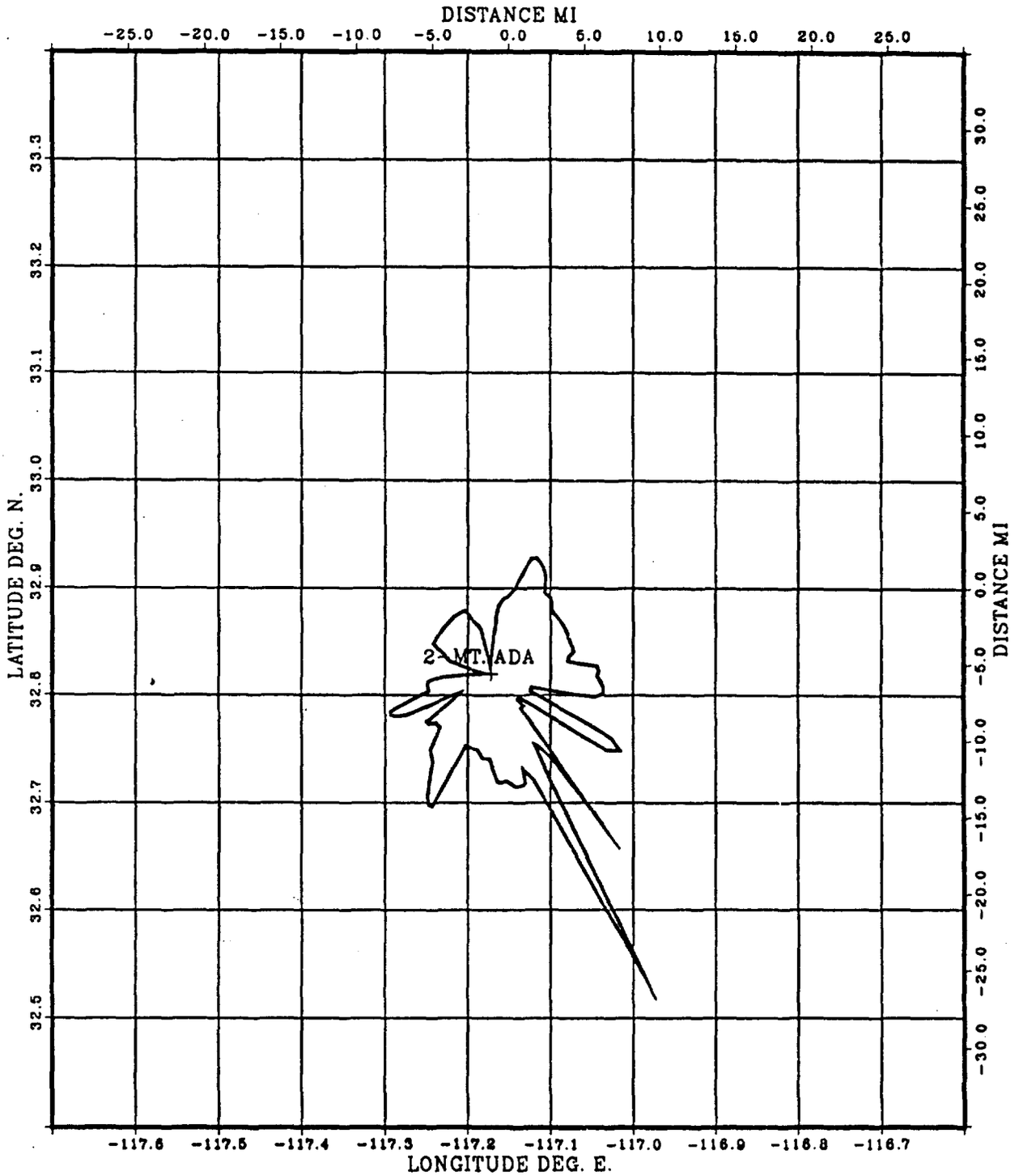


FIGURE 11

39 dBUV/M Coverage Area of Base Site 2-MT ADA Using
Sector Antenna at (256 deg. CW from N.), Ch.G:9

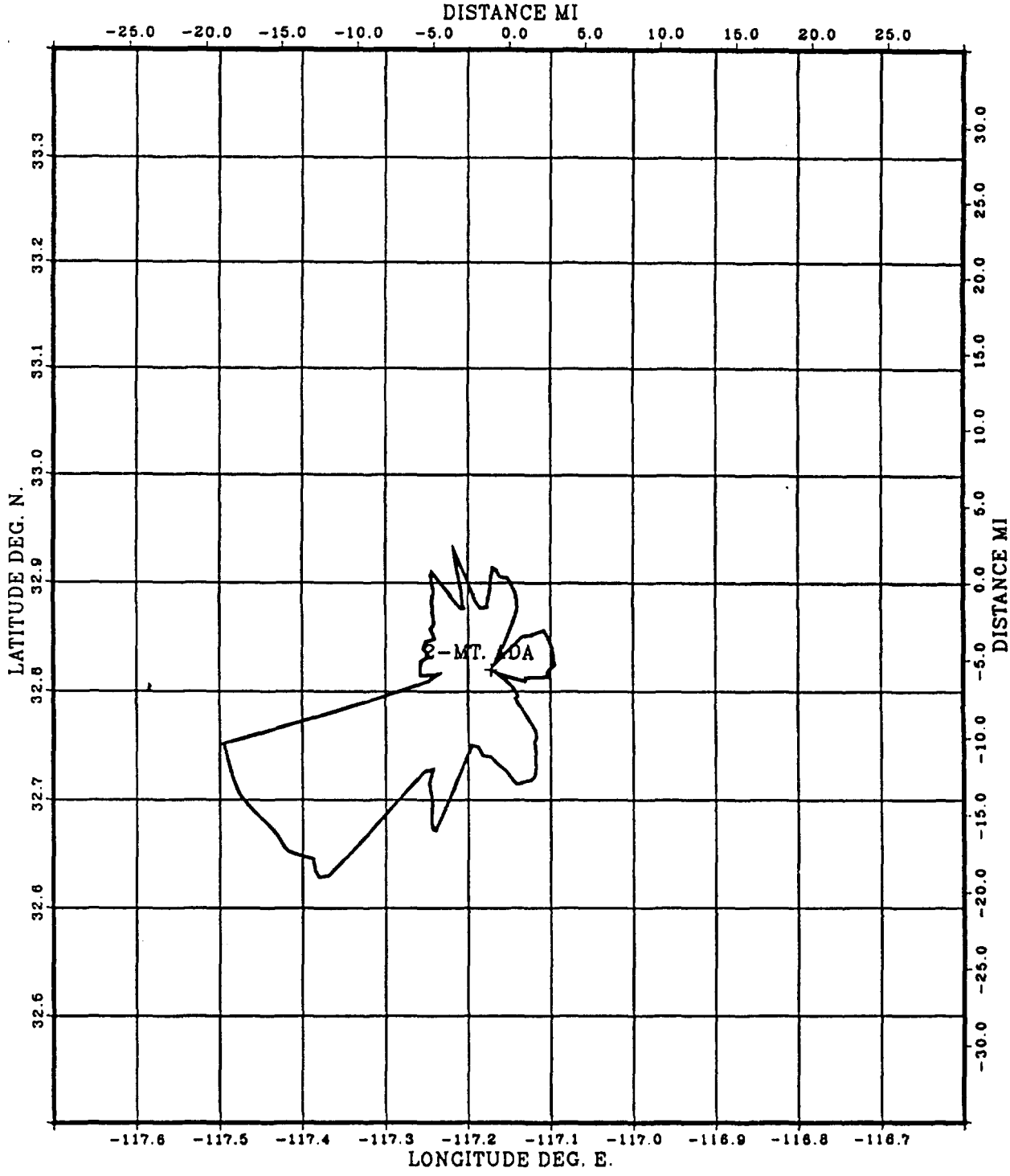


FIGURE 12

39 dBUV/M Coverage Area of Base Site 14-SQUIRES DAM
Channel Groups: 020, 090

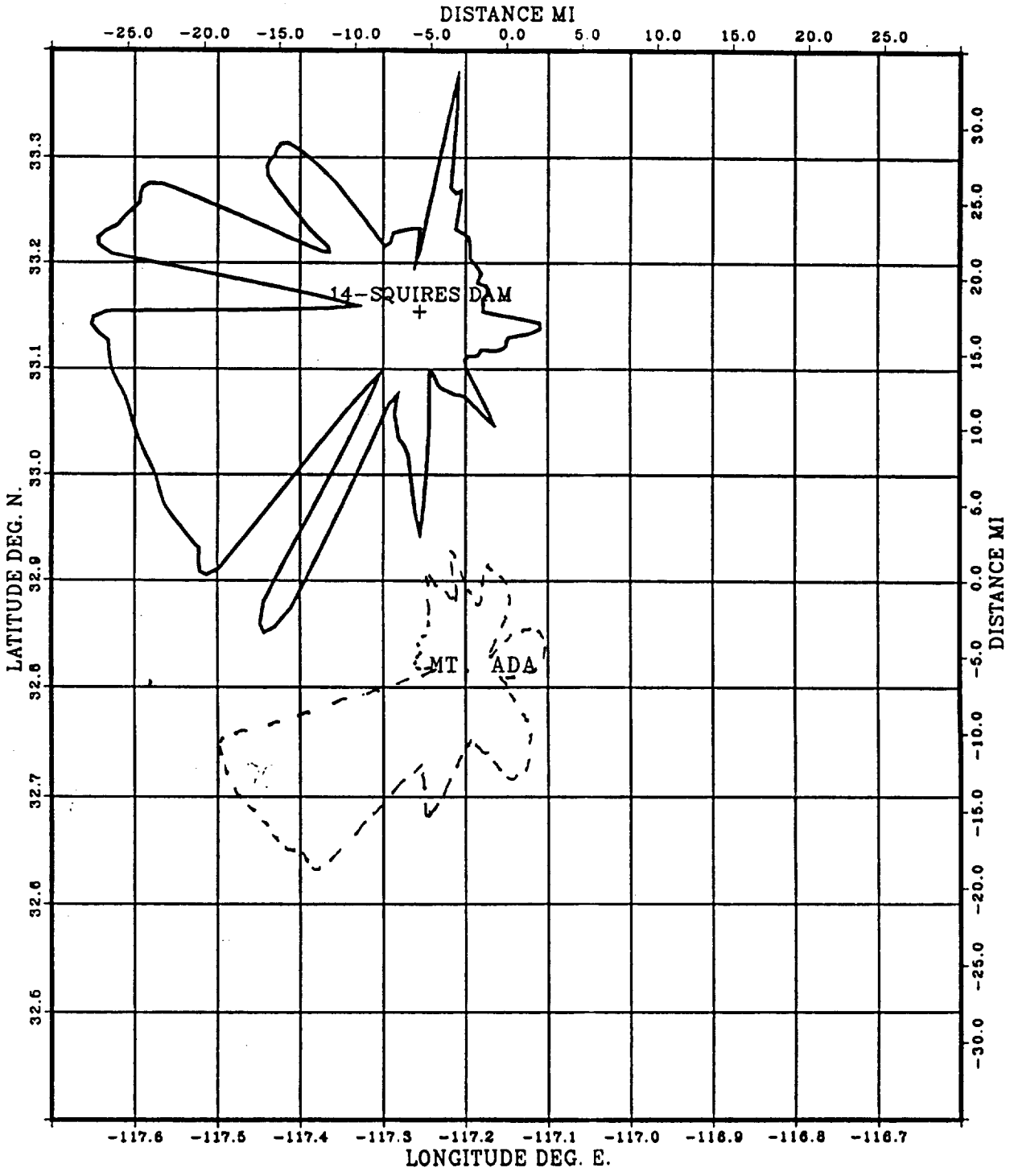


FIGURE 13

Re-Use Cell for Mt. Ada Cell

39 dBUV/M Coverage Area of Base Site 9-SOLANO BEACH
Channel Groups: 030, 171

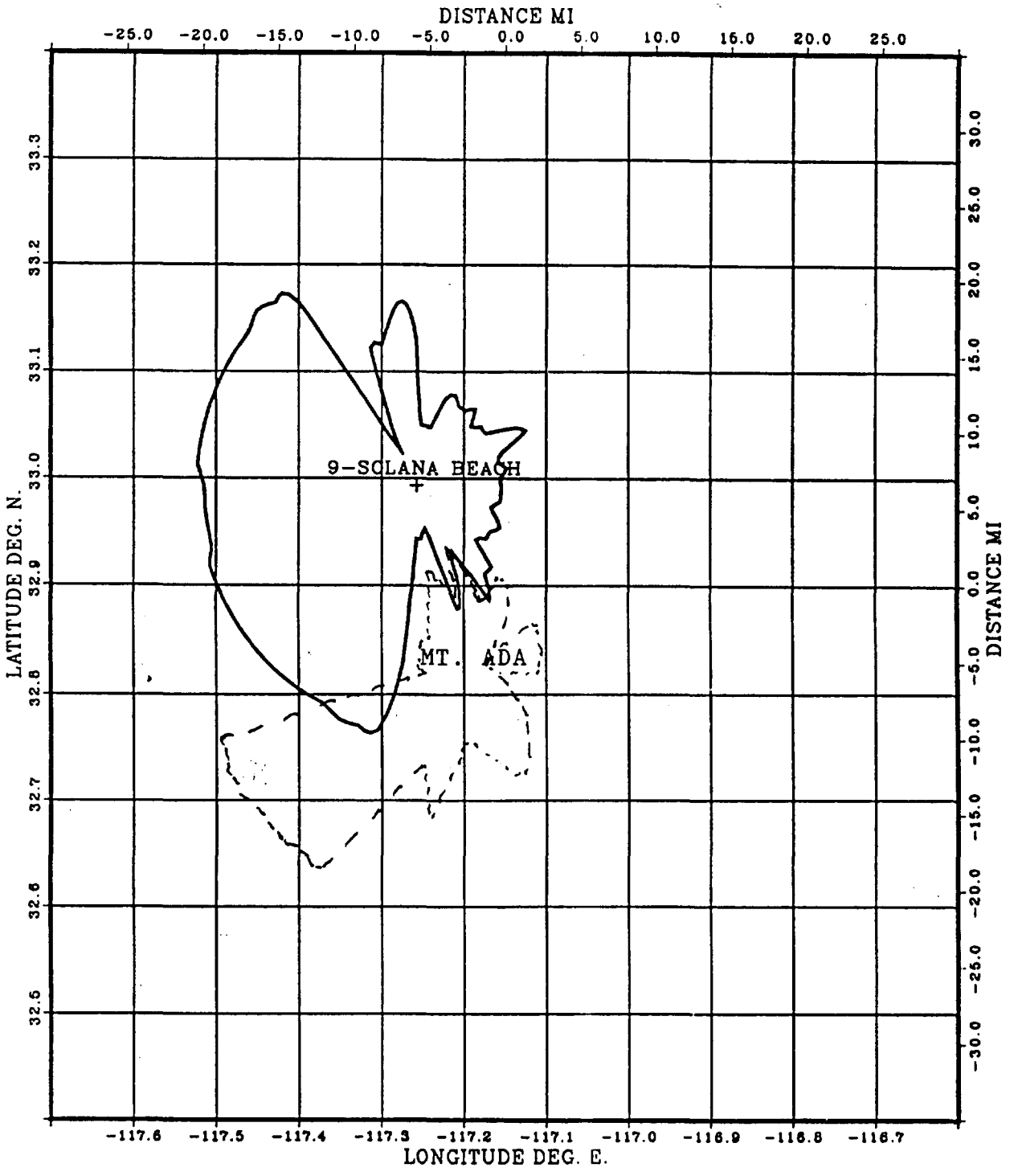


FIGURE 14

FREQUENCY COORDINATION TESTS

C D I

I OVERVIEW

The Cellular Data Incorporated (CDI) data system provides low bit rate data services to User Transponders located throughout an Urban area. The CDI central Base Stations are located at the Base Station sites used by the Corporation providing cellular telephone services. (There are typically 15 to 20 such Base Stations in any urban area.) Each Base Station covers one "cell" of the cellular coverage area. The CDI Base Station transmits data back and forth from a large number of User Transponders within each cell.

The CDI system uses the same band of frequencies used by the cellular telephone service. CDI locates its narrowband data signal halfway between the frequency assignments used by the telephone service. The telephone channels are separated by 30kHz. The narrow-band CDI signal is located ± 15kHz from the center of each telephone channel.

A series of tests were conducted to define the limits on the CDI transmissions that are needed to guarantee non-interference with the normal cellular telephone service.

The interference tests are illustrated by the sketches in Figure 1 and 2. Figure 1 shows the allocation of radio frequencies. The cellular telephone service is allocated a channel every 30kHz in the band. The CDI transmissions use the positions between the cellular telephone transmissions. The adjacent 30kHz channels are labeled 1,2 and 3 in Figure 1. These channel numbers correspond to the cell numbers shown in Figure 2.

Figure 2 illustrates an urban area covered by individual base site locations. Each hexagon is an area covered by a separate base site. The numbers refer to the individual frequency (or set of frequencies) used in the cell. The assignment is a common frequency area coordination pattern to allow Re-use of the cellular frequencies without cells causing interference with each other. The cell labeled 1-REF is taken for reference. Cell 2-ADJ is a cell with a telephone channel assignment only 30kHz away from the assignment in cell 1-REF. The cell labeled 1-REU is a Re-use of the same channel as 1-REF.

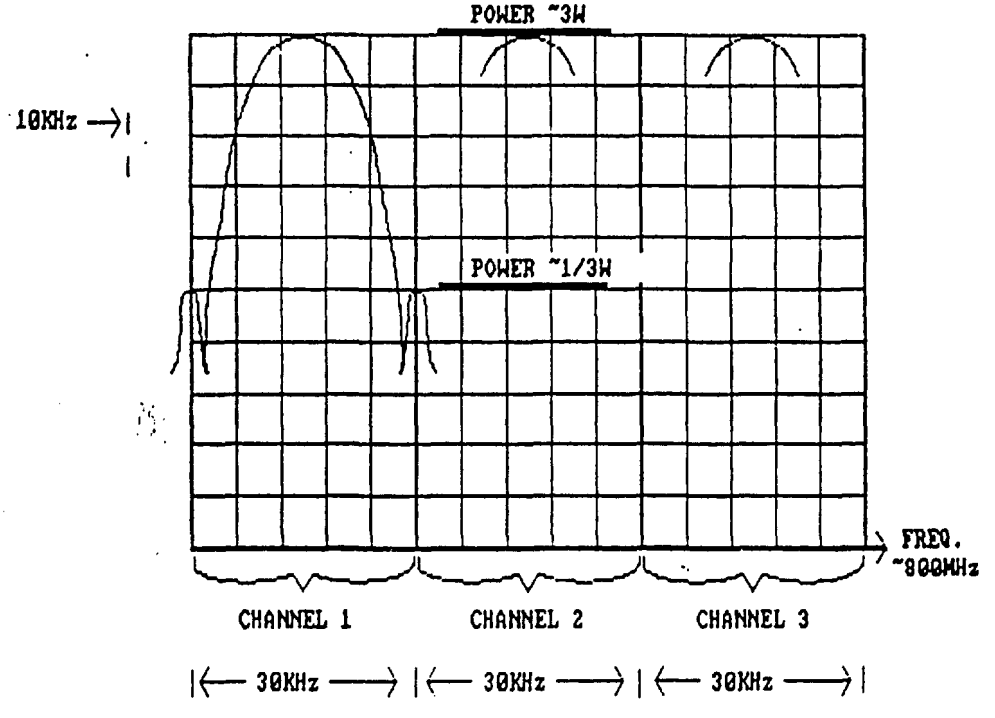


FIGURE 1 - CELL A

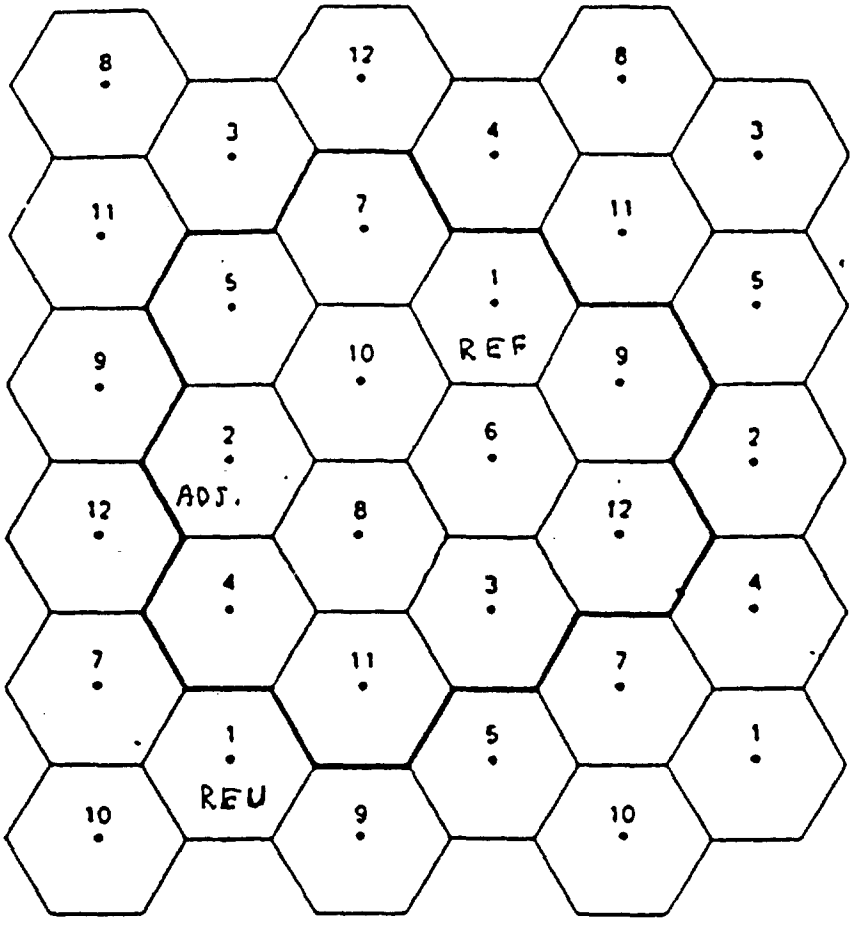


FIGURE 2 - CELL SITE LOCATION

For non-interference of telephone services between cells, no adjacent channel is assigned to an adjacent cell, thus 1-REF and 2-ADJ has cell 10 separating them. For non-interference, the same frequency is assigned only with at least 2 1/2 cell separation. Thus, 1-REF and 1-REU are separated by cells 10, 8 and 4.

The CDI system uses the same pattern of frequency assignments as the cellular service, assigning its channels at ± 15kHz from the channel serving the same cell. In the reference cell there would be a CDI channel at ± 15kHz from channel 1. Three areas of interference should be addressed; interference from CDI transmissions in the 1-REF cell to mobiles within the 1-REF cell, interference from the CDI transmissions in REF-1 cell to mobiles using channel 2 in the 2-ADJ cell and interference from the CDI transmissions in REF-1 cell to mobiles using channel 1 in the 1-REU cell.

The tests described in the following report tested the interference between the CDI system and mobile services within the reference cell and from the reference cell to mobile services in the adjacent channel cell and in the Re-use cell.

The tests establish power limits for CDI transmissions from the Base Stations and from the user transponders to ensure non-interference. These limits are low enough to prevent interference to the cellular telephone service and high enough to provide the CDI data services reliably.

The sketches in Figures 1 and 2 are idealized. In the actual systems, terrain, fading, and strategies of frequency assignment make the picture more complicated. The tests were carried out in Pac-Tel's Cellular facility in San Diego. Besides establishing the frequency coordination parameters, the tests also defined a number of techniques simplifing the implementation of the CDI service.

The tests and results are described below.

III INTERFERENCE TEST EQUIPMENT

In the tests, transmissions from the Base Stations were made on the normal Base Station radio of the Pac-Tel telephone service. The runs were made after 7:00 p.m. and before 6:00 a.m. of the next morning. The signals were received by a cellular telephone, (Motorola 3500). The telephone was either making a normal call (dialing was done until the test channel was chosen) or the cellular channel was placed in a test mode. In the "test" mode, the mobile phone was not adjusted in its transmitted power level. In the normal mode, the mobile power was controlled by the cellular switch to meet coverage criteria. In these two modes, no change was made to the normal Base Station transmitter antenna. For security of the cellular service, no connectors were changed.

On one occasion, to test the use of a common antenna for the transmission of cellular and CDI signals, a spare antenna at Mission Valley was used. In this test, the normal cellular transmitter was disabled and a Motorola test set (Model 2001) plus power amplifier (Amplifier Research 5W1000) was used to generate the cellular signal to the mobile. This was done to avoid having to uncouple the operational cellular transmitter from its antenna.

Figure 15 shows a picture of the Mission Valley test site with the test antennas identified.

During the test, a standard test tape was used to transmit a 6.0kHz deviation 1kHz tone from the Base Station transmitter to the mobile. The received audio signal was recorded on a recorder (Sony WM-D3) in the mobile for later processing. The "squelch" control in the mobile was suppressed so that any interference, whether due to fading or CDI signals, would be recorded as an increase in the noise level relative to the 1kHz test signal.

An audio tape was recorded during each run. Voice comments were recorded on the second channel describing locations and describing test conditions.

The tape was played back in the laboratory. A 1kHz notch filter (Krohn-Hite 3342) was inserted to eliminate the test tone and the noise power detected and recorded on a chart recorder (Graphtec WR7500/ACL3101).

The CDI transmission was generated by FM modulating a synthesizer (H.P. Model 8656B) with a 1kHz tone deviated to 3kHz peak. This generates a signal somewhat wider than the CDI signal. For some tests, the deviation was increased to determine sensitivity to CDI spectral width. The frequency was set to a point 15kHz off of the cellular frequency. In some tests, the frequency was set to 7, 10, 15 and 20 kHz to test sensitivity to CDI frequency errors.

The power level was set to various levels for the different test runs. The frequency offset and power levels were usually initially set to deliberately cause interference (by moving the CDI transmissions into the cellular telephone bandwidth) in order to ensure that all systems were working. The test then changed frequency and power to determine acceptable protection margins. The CDI signals were keyed on and off at six second intervals so that their signature could be recognized.

Power levels of cellular signals and CDI signals were monitored with the Tektronix 2710 spectrum analyzers.

The equipment used in the Base Station for the outbound tests is shown in Figure 16. The equipment used in the mobile receiver is shown in figure 17. The equipment used to reduce the data in the laboratory is shown in Figure 18.

Figure 19, 20 and 21 illustrate the spectra of the 'normal cellular telephone transmissions. In Figure 19, there is no audio signal generated, only the 6kHz SAT tone, used to identify the cell, is seen in the spectrum. (The CDI transmission will reside between the 2nd and 3rd harmonic of the SAT tone.) Figure 20 shows the same radio with the 1kHz test tone at 6kHz deviation applied to the audio. Figure 21 shows the spectrum modulated by a voice passage. The voice spectrum is highly varied and will change second to second.

Figure 22 shows the CDI spectrum at a typical level. It is set 15kHz off from the center of the cellular telephone channel shown on the previous Figures. Figure 23 shows the CDI and the Cellular channels together. (The relative levels are for illustration only, the actual values needed for protection are determined by the test.)

Figure 24 shows an example of the data reduction. In the upper curve the audio noise level is varying from the 0dBR minimum noise level to 35dBR, the worst noise level with the signal actually gone. (The chart is calibrated so that 0dBR corresponds to a 35dB SINAD, the noise level of the tape recorder used.) The upper curve shows noise bursts due to fading of the Base Station signal into the background noise level at this point, the CDI signals are not being transmitted. The lower curve in Figure 24 shows the CDI transmissions, causing interference. Here, the 6-seconds-on, 6-seconds-off of the CDI transmissions can be identified clearly in the recording. This run was made with the CDI transmission at 7kHz offset (i.e. within the bandwidth of the cellular receiver) in order to illustrate the interference.

For the Inbound CDI tests, the Mt. Ada Base Station was used. The CDI transmitter was set up at a site about 1 mile from the Base Station within the Gamma sector antenna pattern. It was adjusted to the right frequency offset and power to be received at the Base Station. In the Base Station the normal receiving antenna for the cellular service comes into a pre-amplifier from