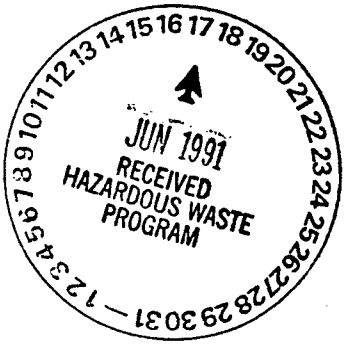
DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 27TH COMBAT SUPPORT GROUP (TAC)
CANNON AIR FORCE BASE, NM 88103

13 JUN 1991



Mr Benito Garcia
New Mexico Environmental Division
Hazardous/Radioactive Waste Bureau Chief
P. O. Box 26110
Sante Fe, NM 87502

RE: Compliance Order/Schedule
Cannon Air force Base
NM 7572124454
Docket Number 901002

Dear Mr Garcia

Attached is the Report on Explorations for Location of Landfill Cells at Sanitary Landfill 5 identifying the location of cells in Landfill 5. The survey shows the cells were not dug according to the specifications set forth in the Landfill Management Plan. We do not feel there is conclusive evidence as to the exact location of the North and South boundary of cell 3. All cells in the location of cell 3 are larger than illustrated in the Management Plan. Therefore, the cap design was inadequate to completely cover cell 3. Consequently, we request your consideration in meeting with us to discuss resolution of this matter.

The U. S. Air Force and Cannon AFB are totally committed to full compliance with all regulatory requirements. We at Cannon have placed resolution of this matter as our highest priority. We look forward to working with your agency to develop the best solution to this matter.

Any questions about the survey report or dates of a meeting can be directed to Mr. Jim Richards at 784-4639.

Sincerely

DAVID E. BENSON, Colonel, USAF
Commander

2 Atch
1. Survey Report
2. Cell Location Map

cc: 27 TFW/CV
HQTAC/DEV

Readiness is our Profession

DEPARTMENT OF THE ARMY
TULSA DISTRICT, CORPS OF ENGINEERS
POST OFFICE BOX 61
TULSA, OKLAHOMA 74121-0061

REPLY TO
ATTENTION OF

CESWT-EC-G (200)

5 June 1991

MEMORANDUM FOR Commander, Cannon Air Force Base, 27CSG/DEV,
Cannon AFB, NM 88103-3251

SUBJECT: Report on Explorations for Location of Landfill Cells at Sanitary Landfill No. 5

1. Reference scope of work for Corrective Measures in Compliance Agreement at Cannon Air Force Base - Landfill 5, Tulsa District Corps of Engineers.

2. In accordance with paragraph 2.4 of the scope of work, an original map of the landfill cell boundaries is forwarded. The map is also available on computer disk. The survey of the cell corners was completed by Wilson Surveying Co. Inc., a registered professional land surveyor in the state of New Mexico, No. 7475. The surveyors statement and seal is attached to the map. A report on the investigations is also included.

3. Point of contact is Mr. Bill Bowen, Geotechnical Branch, telephone 918-581-6148.

FOR THE COMMANDER:

Encl

FRANK W. PARKER, P.E
Chief, Engineering and
Construction Division

Explorations For Location of Landfill Cells At Sanitary Landfill No. 5

Cannon Air Force Base
Clovis, New Mexico

Prepared For Environmental Management
Cannon Air Force Base
Clovis, New Mexico

By
U.S. Army Corps of Engineers
Tulsa District
May 1991

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Explorations For Location of Landfill Cells At Sanitary Landfill No. 5

Cannon Air Force Base
Clovis, New Mexico

1.0 Introduction and Purpose. This work was performed in compliance with a request by Cannon Air Force Base (AFB) to satisfy requirements by the New Mexico Environmental Improvement Division (NMEID). The purpose of this report is to present the investigations performed and the subsequent results of an attempt to locate landfill cells within the sanitary landfill 5 boundaries. The preferred methods for locating the landfill cells were geophysical methods which included electromagnetic conductivity, magnetometer and magnetic gradiometer surveys. The geophysical methods are the least disruptive of the existing landfill. The secondary method was to use geotechnical methods (trenching and spot digging). Geotechnical methods were also to be used to verify (ground truth) what was found by the geophysical surveys

2.0 Site Description.

2.1 **General Location and Land Use.** Cannon AFB is located approximately 7 miles west of Clovis, New Mexico (see Figure 2-1). Primary land use in the area around Cannon AFB is for cattle ranching and irrigated farming. The primary source of irrigation water for the area is the Ogallala Aquifer (USACE 91).

2.2 **History.** Cannon AFB has been assigned to the Tactical Air Command since 1951. Since 1971, the primary mission of Cannon AFB has been to develop and maintain a F-111 tactical

fighter wing, capable of day, night and all-weather combat operations and to provide replacement training of combat air crews for tactical organizations worldwide.

2.3 **Landfill 5 Description.** Landfill 5 is not currently active. Use of the landfill area began in 1968 and ended in 1990. The site covers an area of approximately 30 acres in the southeast corner of the base. From 1968 to 1972, the mode of operation at landfill 5 was to burn and bury trash in the landfill cells. Since 1972, unburned waste has been buried. A reported 19 buried cells were to be in existence at the site. One cell, cell 3, reportedly received hazardous waste after the effective date of RCRA. A clay and flexible membrane cover was constructed in 1989 to cover cell 3. The location of the landfill on base is shown in Figure 2-2.

3.0 Geologic Description.

3.1 **Regional.** Cannon AFB is located in the Southern High Plains section of the Great Plains province. The southern high plains consist of an isolated plateau bounded on the north by the Canadian River and on the east and west by escarpments which rise 300 feet above the surrounding area. Cannon AFB is located near the center of plateau where the topography is typically flat featureless terrain containing numerous playa lakes. Land surface elevations range from 4,327 feet above mean sea level (MSL) at the northwest corner of the Base to 4,260 feet above MSL in the southwest corner of the Base. Cannon AFB is underlain by thick unconsolidated stratigraphic section of gravel, sand,

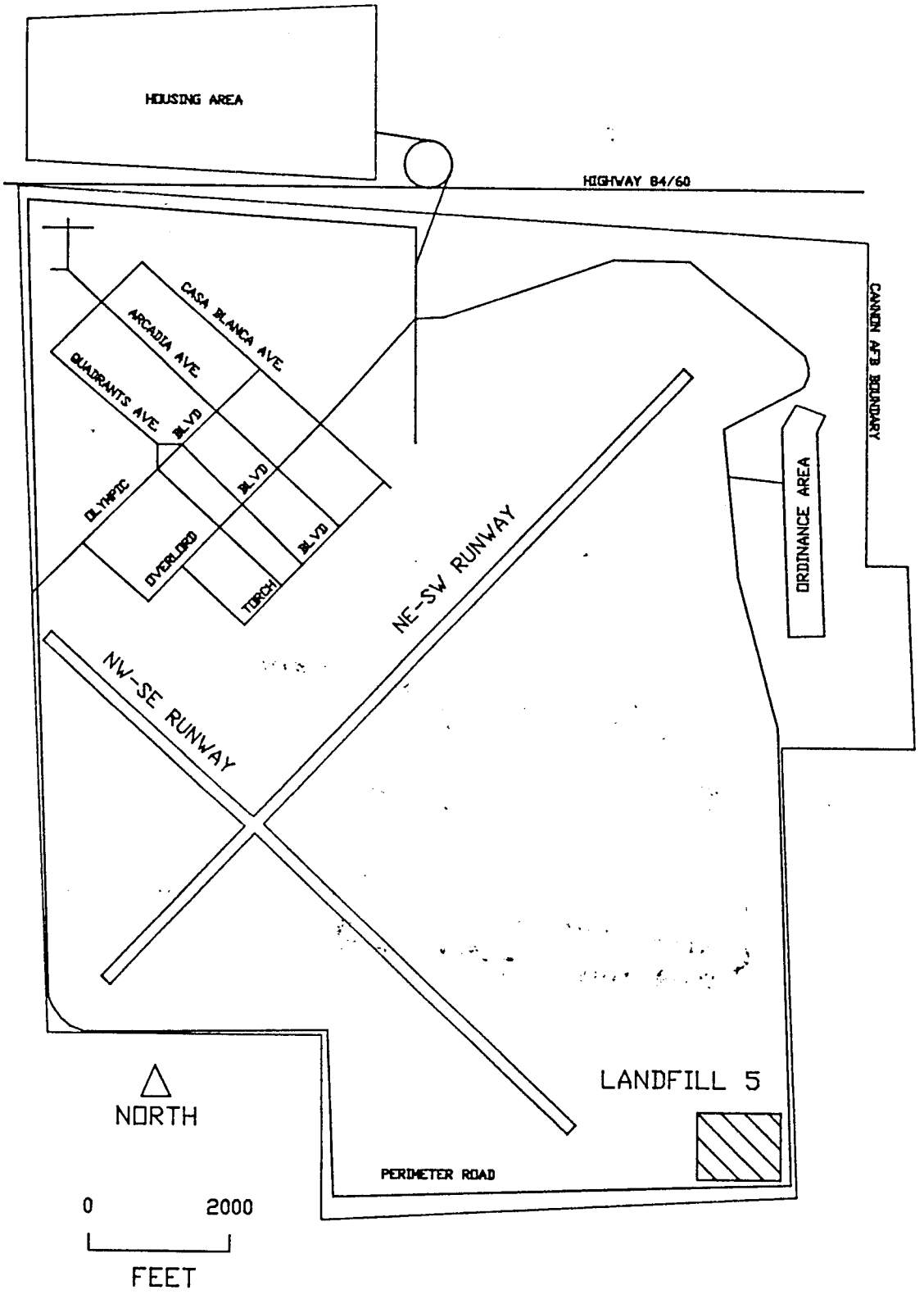

Figure 2-2. Location of Landfill 5 on Cannon AFB.

silts, clays and caliche which extends to 400 feet below the ground surface. In areas where the units are saturated they form part of the Ogallala aquifer. The base of the aquifer is considered to be of the Triassic age Dockum Group. The depth to groundwater in the vicinity of Cannon AFB is 250 to 300 feet. The potentiometric gradient within the Ogallala is to the east and southeast at 7 to 15 feet per mile. Similarly, the regional dip of the Ogallala Formation is 10 to 15 feet per mile to the east in the area of Cannon AFB (USACE 91).

3.2 **Landfill 5.** Based on previous drilling, soil consisting of dark brown fine to medium grained silt and sand exists from the ground surface to 4 or 5 feet. Caliche is found from 4 or 5 feet to approximately 65 feet. Within the caliche profile are layers of silt and weakly cemented sand. From 65 to 185 feet, unconsolidated sands are present. A clay lens is present from 190 to 195 feet in depth beneath which lies thickly bedded, fine to coarse grained, unconsolidated sands, silts and gravels.

4.0 Geophysical Survey.

Three separate geophysical surveys including a electromagnetic conductivity survey, a magnetometer survey, and a gradiometer survey were conducted within an area surrounding the existing clay cap. An electromagnetic conductivity survey was conducted within a test area of 425 X 875 feet and the gradiometer and magnetometer surveys were conducted within a test area of 600 X 875 feet. If these methods proved successful the entire landfill area was to be surveyed. The survey grid and the

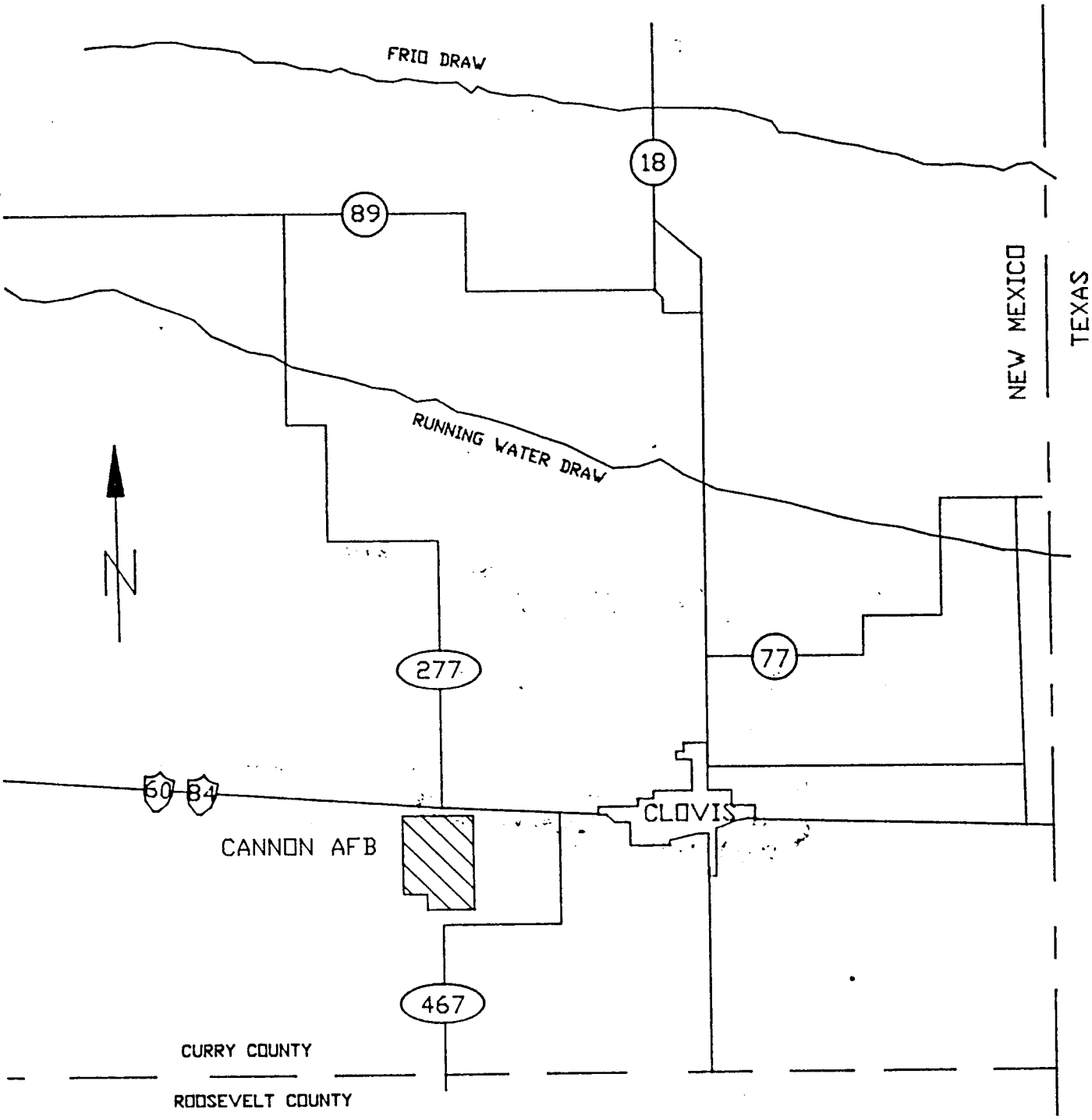

FIGURE 2-1. CANNON AFB LOCATION MAP

three geophysical techniques employed in the survey are described below.

4.1 **Survey Grid.** Prior to the initiation of a geophysical survey, the landfill area was gridded into 25 feet x 25 feet areas based upon known survey coordinates at numerous locations around the landfill. A grid of 25 feet x 25 feet was chosen because of the area of investigation and the manufacturer recommendations set for each geophysical instrument. Corps of Engineers metal survey tablets were used as reference points for the grid. A wood stake or spot of highly visible survey paint was used to mark the location of the grid node points.

4.2 **Electromagnetic Conductivity (EM) Survey.** In an electromagnetic conductivity survey, a transmitter coil is energized with an AC current at an audio frequency. A receiver coil is placed at a short fixed distance away. The receiver coil picks up the induced secondary magnetic fields produced by the small electric currents induced into the earth by the transmitter coil. Along with this, the primary magnetic field of the ground below the receiver is picked up. The ratio of the primary magnetic field to the secondary magnetic field is linearly proportional to the ground conductivity (Driscoll 1986).

The EM meter used was a EM-31DL, which has an effective penetration depth of approximately 6 meters. Before use, the EM-31DL was calibrated and run through a field test. During the survey, two measurements were taken at each node point. One measurement was taken along the north-south lines and the another

measurement was taken at 90 degrees along the east-west lines. The two values were then averaged to yield the conductivity value for that node point. Units of measure for the conductivity meter were in mmhos/meter. Throughout the survey a tiebase point (specific point in which readings are repeatedly taken throughout the day) was used in order to check the calibration of the instrument.

4.3 **Gradiometer Survey.** A gradiometer survey was performed in order to locate the cells through means of locating possible buried ferrous material and magnetically anomalous areas. The magnetometer used for the gradiometer survey was the Scintrex Omni-Plus magnetometer/gradiometer/(very low frequency) VLF system. This system is a proton magnetometer with a gradiometer and VLF capacity (EDA 1988). The gradiometer measures the earths magnetic field at 2 points located vertically 0.5 meters apart simultaneously. The magnetic gradient between these two points is then calculated. The units of measure for the gradiometer is gammas/meter.

Before the survey was initiated, the gradiometer was run through an internal central processing unit (CPU) test. Internal fine tuning to the local magnetic field was carried out automatically therefore no external tuning of the instrument was necessary. Because the gradiometer sensors take the reading of the magnetic field simultaneously there was no need to correct for the fluctuations of the earths magnetic field.

4.4 **Magnetometer Survey.** Total field magnetic readings were

taken along with the magnetic gradient readings mentioned above. The same magnetometer system was used.

In order to account for the diurnal fluctuations of the earths magnetic field a series of tiebase readings were taken during the survey. This data was saved along with the subsequent time at which the reading was taken via an internal clock. The Omni-Plus has an internal correction algorithm to correct the data for these diurnal fluctuations. The magnetometer system works on the principle that buried ferrous or magnetically anomalous material will effect the reading of the total field magnetics at that particular location. The magnetometer measures these subtle changes in the magnetic field (in the U.S. the field ranges from 50,000 to 60,000 gammas) to a sensitivity of 0.1 gamma. Anomalies can then be mapped.

5.0 Geotechnical Investigation. Following interpretation of the geophysical survey, actual verification of some of the trends found through geophysics as well as areas believed to contain buried cells was undertaken. This procedure involved spot digging and trenching in areas of suspected cells in a methodical manner in order to locate the true boundaries of the reported 19 landfill cells. Cell boundaries were located through examination of numerous pits for distinct geological change from native soil to fill dirt and trash. Once the cell boundaries were located, the corners of the cells were marked for a later survey.

6.0 Results.

6.1 **Geophysics.** The geophysical surveys that were conducted

did not adequately define the cell boundaries, yet were used to aid in locating possible areas to begin geotechnical investigations. Figures 6-1, 6-2 and 6-3 show the results of the geophysical surveys. The contoured area on each figure is the test area used for the survey. The rectangular area in the test area is the outline of the capped area. The magnetometer survey indicated numerous magnetically anomalous areas. Two of these areas were confirmed to be large buried metallic objects. Metal objects were very prevalent at the surface of the landfill and therefore magnetic geophysical surveys were severely hindered. Figure 6-1 is a map showing the results of the magnetometer survey.

The gradiometer survey results were very similar to the magnetometer survey. No boundaries were distinguishable by the magnetic gradient anomalies. Figure 6-2 shows the results of the gradiometer survey.

The electromagnetic conductivity survey appeared to indicate some linear cell features. However, distinct boundaries of the cells were not distinguishable. The presence of buried metal throughout the landfill and the metallic fence surrounding the clay cap appeared to affect the conductivity readings. Figure 6-3 shows the results of the electromagnetic conductivity survey.

6.2 **Geotechnical Methods.** A total of 25 separate buried cells were located within the landfill 5 area using geotechnical methods (spot digging and trenching). Of these 25, there were a total of 5 cells found to extend beyond the limits of the

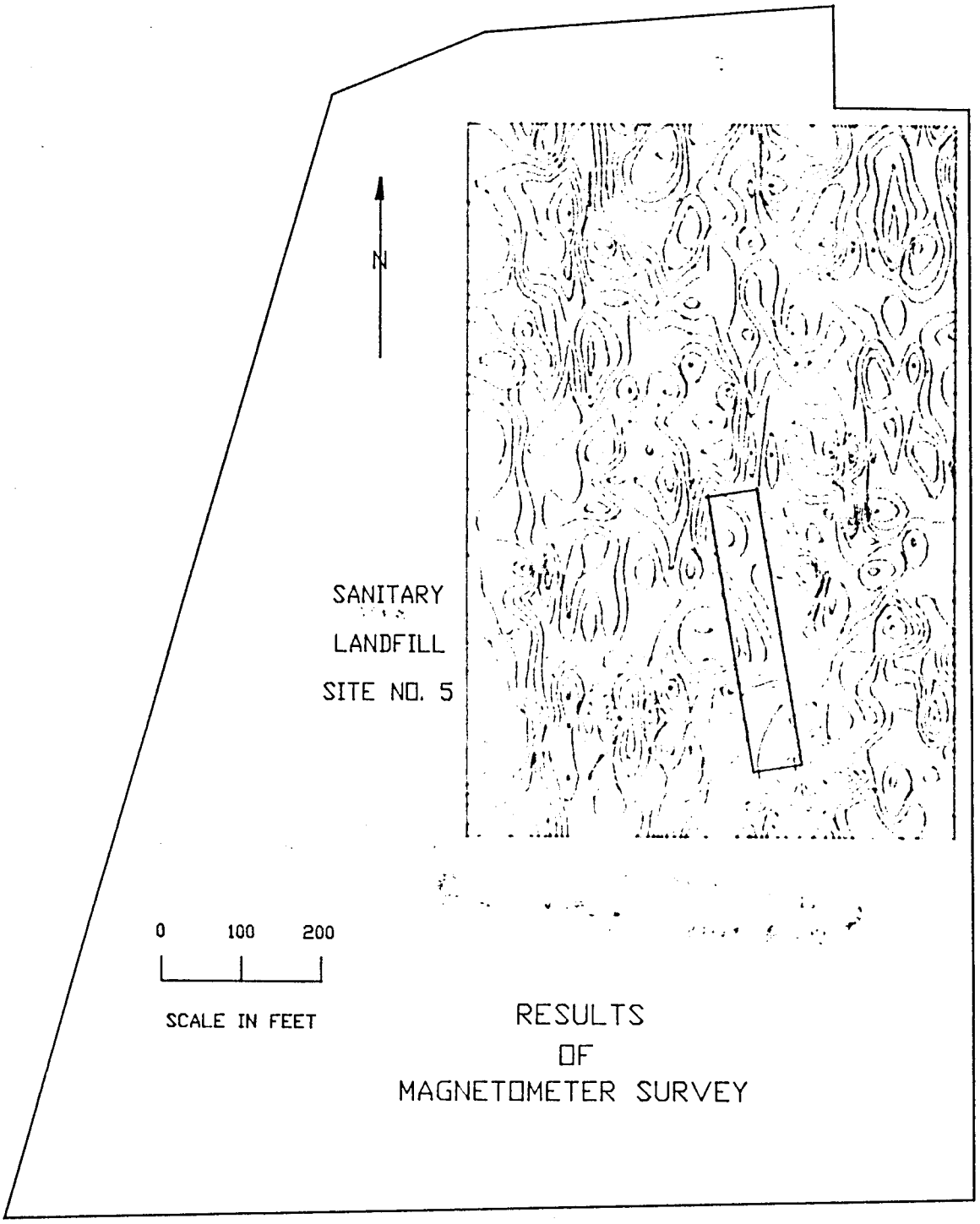
N
SANITARY
LANDFILL
SITE NO. 5
0
100
200
SCALE IN FEET
RESULTS
OF
MAGNETOMETER SURVEY

Figure 6-1

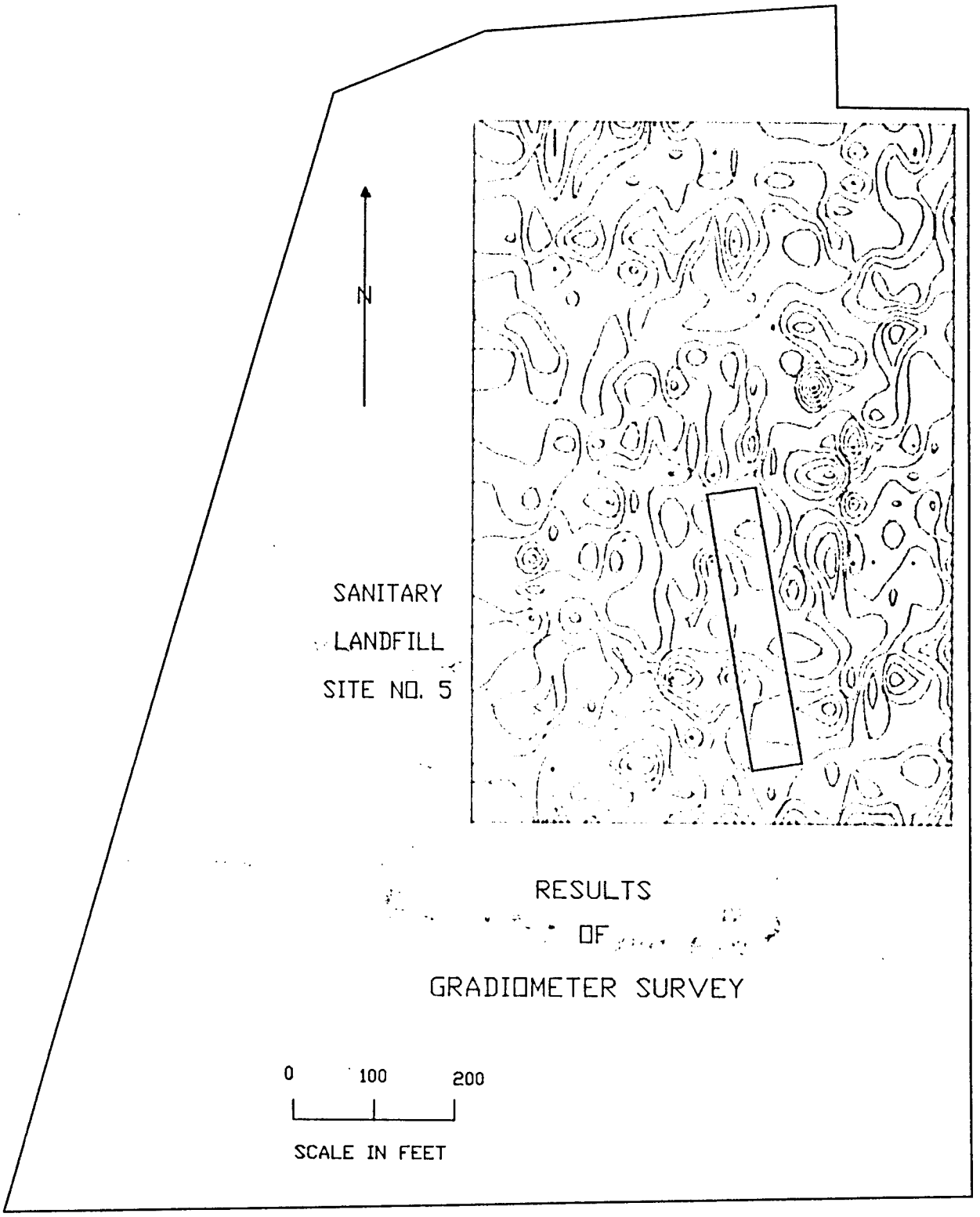
N
SANITARY
LANDFILL
SITE NO. 5
RESULTS
OF
GRADIOMETER SURVEY
0
100
200
SCALE IN FEET

Figure 6-2.

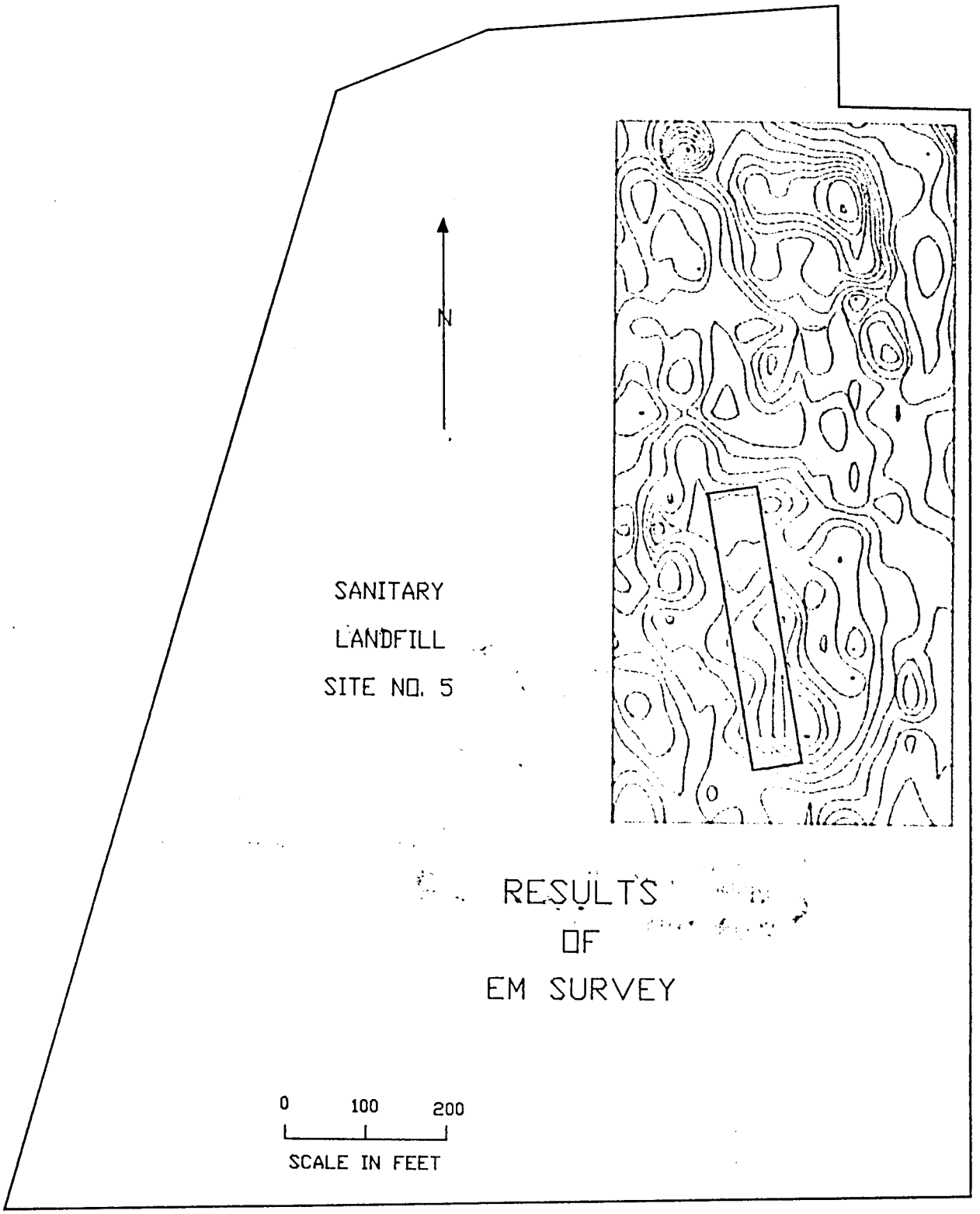
N
SANITARY
LANDFILL
SITE NO. 5
RESULTS
OF
EM SURVEY
0
100
200
SCALE IN FEET

Figure 6-3.

existing fence line. Cell corners were staked, marked and later surveyed for elevation and state plane coordinates. During the survey, iron rods were placed at the locations of each corner. Appendix A lists the state plane coordinates and elevations for each corner or intersection of a cell with the fence line. A fold out map of the survey results and cell locations can be found in the back of this report.

7.0 Conclusions. A total of 25 buried landfill cells were found to be located within the fence line of the sanitary landfill 5 instead of the 19 cells reported to be present. Five cells extended beyond the fence line. The investigation began with an initial geophysical survey which yielded only limited information as to the location of cell boundaries. Following this a geotechnical investigation of the entire landfill area which included spot digging and trenching was useful in tracing the cell boundaries by locating their edges. Corners of the cells were marked and surveyed for elevations and state plain coordinates, and a comprehensive map of the located cell corners was drafted. The map showing the locations of the cells is attached to this report.

REFERENCES

Driscoll, Fletcher G., Groundwater and Wells, 2nd Ed., 1986.

EDA Instruments Inc., Sintrex Operations Manual Omni-Plus VLF/Magnetometer System, Revision 2.21, July 22, 1988.

Hempen, Gregory L. Hempen, Engineering Geophysics For Hazardous Waste Site Studies, Seminar notes Oklahoma Section of the Engineering Geologists, May 1990.

U.S. Army Corps of Engineers, Drilling and Installation Plan For Monitoring Well L At Landfill 5 Cannon Air Force Base, Draft, January 1991.

Appendix A
Landfill 5 Cell Corner Coordinates

CANNON AIR FORCE BASE LANDFILL 5
COORDINATES BASED ON NAD 1927
ELEVATIONS BASED ON NGVD 1929

PT#	X	Y	Z
1	811012.452827	1226288.535571	4261.918900
2	811024.984197	1226249.198757	4262.969300
4	810507.493712	1226022.679251	4264.856300
5	810532.827772	1225992.779202	4264.756500
6	810397.605165	1226087.303592	4265.025600
7	810546.191120	1226108.067289	4263.769200
8	810614.333651	1226084.098876	4263.902000
9	810763.019608	1226184.526592	4262.824500
10	810828.729129	1226211.928435	4262.276400
11	810941.441157	1226254.178057	4262.408300
12	810979.990124	1226268.464822	4262.477600
13	811001.706459	1226316.034957	4261.804600
14	810970.452498	1226305.622865	4262.667600
15	810868.094015	1226370.309850	4263.969500
16	810855.283659	1226370.760095	4263.731100
17	810797.249314	1226354.699541	4263.912400
18	810311.107515	1226060.207018	4264.618100
19	810263.607544	1226058.890415	4264.415100
20	810235.883093	1226095.884852	4265.130700
21	810256.195111	1226143.912758	4264.743500
22	810215.107234	1226220.208596	4265.019100
23	810221.826012	1226295.927207	4264.251200
24	810240.374931	1226296.853992	4264.678000
25	810241.436970	1226372.408134	4265.300200
26	810003.823424	1226359.858171	4263.351200
27	809993.264296	1226323.483027	4262.965200
28	809992.695284	1226321.367886	4262.983100
29	809981.182211	1226254.327854	4264.009500
30	809965.050895	1226207.024750	4264.086700
31	809956.030176	1226165.898656	4264.347900
32	810643.720361	1226359.064517	4263.044300
33	811034.016931	1226405.037384	4262.499800
34	811006.448432	1226405.680507	4262.918400
35	811068.464672	1226713.241339	4265.988200
36	811015.563348	1226707.483538	4266.254100
37	811001.842337	1226836.959001	4264.040400
38	810967.228026	1226837.432701	4263.656700
39	810967.367897	1226844.935581	4263.633200
40	811001.737583	1226849.273147	4263.691700

41	811067.125415	1227244.466444	4265.376500
42	811015.959560	1227247.744927	4264.312900
43	811010.780412	1227305.730559	4264.801300
44	810911.842679	1227308.199819	4265.786400
45	810830.850583	1227308.007282	4265.109300
46	810832.053773	1227398.089048	4265.699100
47	810766.840977	1227399.592420	4265.475500
48	810745.289597	1227402.348645	4265.918300
49	810571.105584	1226740.087570	4265.125400
50	810512.743467	1226731.759627	4264.885500
51	810465.755907	1226608.069046	4264.519900
52	810508.707391	1226595.555999	4265.269300
53	810435.609266	1226593.422444	4264.228100
54	810395.479146	1226602.826967	4264.194100
55	810478.181557	1227243.224487	4264.824300
56	810561.394546	1227267.871086	4265.011200
57	810556.916525	1227325.349559	4265.329700
60	810629.578991	1227405.126186	4266.164600
61	810696.834831	1227402.660965	4265.316600
62	810455.125062	1227351.163139	4266.046300
63	810463.836744	1227317.195469	4265.461400
64	810277.701414	1227234.087984	4263.289400
65	810287.608470	1227173.658986	4263.878800
66	810358.949120	1227109.443231	4265.067900
67	810423.052287	1227227.353294	4264.671400
68	810410.783048	1227253.642073	4264.209200
69	810456.887147	1227108.659752	4264.709000
70	810914.472474	1226384.023057	4264.336900
71	810191.378326	1226999.650406	4263.681900
72	810157.844671	1226886.010324	4262.731000
73	810047.308070	1226391.808866	4263.440000
74	810062.975424	1226395.891086	4264.130000
75	810084.400636	1226403.128479	4263.950000
76	810127.541018	1226365.971765	4263.190000
77	810209.445980	1226371.564941	4265.340000
78	810032.009714	1226458.177561	4262.940000
79	810039.123531	1226482.347074	4263.180000
80	810055.776760	1226539.991856	4263.470000
81	810090.299786	1226656.536692	4263.880000
82	810136.472192	1226812.260466	4262.930000
83	810266.373143	1226700.697522	4263.830000
84	810311.154460	1226705.686936	4263.710000
85	810353.340730	1226530.424461	4263.660000
86	810314.498549	1226527.018111	4263.970000
87	810306.113677	1226986.848796	4264.240000
88	810356.096712	1226992.249234	4265.570000

89	810291.164362	1227155.885071	4263.870000
90	810238.044216	1227155.562574	4263.750000
92	810627.322870	1227446.556892	4265.090000
93	810541.234611	1227443.056230	4266.000000
PS1	810874.220000	1226511.420000	4266.960000
PS2	810816.410000	1226856.190000	4266.910000
PS3	810813.450000	1226501.330000	4266.750000
PS4	810755.620000	1226846.450000	4267.110000