ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

March 29, 1996

Mr. David Fauver
U.S. Nuclear Regulatory Commission
Division of Waste Management - NMSS
Two White Flint North T-8F37
11555 Rockville Pike
Rockville, MD 20852

SUBJECT: FINAL REPORT - CONFIRMATORY SURVEY OF THE PHASE I UNAFFECTED AREAS, KERR-McGEE CORPORATION, CIMARRON FACILITY, CRESCENT, OKLAHOMA (DOCKET NO. 79-0925; RFTA 96-01)

Dear Mr. Fauver:

The Environmental Survey and Site Assessment Program (ESSAP) of ORISE conducted a confirmatory survey of the Phase I Unaffected Areas at Kerr-McGee's Cimarron Facility in Crescent, Oklahoma on October 17 through 19, 1995. Confirmatory survey activities included surface scans, exposure rate measurements, and soil sampling.

Enclosed are 5 copies of the subject document. The draft report was revised as requested. If you have any questions, please direct them to me at (423) 576-3740 or W. L. (Jack) Beck at (423) 576-5031.

Sincerely,

Eric W. Abelquist

Eric W. Abelquist
Assistant Program Director
Environmental Survey and
Site Assessment Program

EWA:tsf

Enclosure

cc: R. Uleck, NRC/NMSS/TWFN 7F27
D. Tiktinsky, NRC/NMSS/TWFN 8A23
W. Beck, ORISE/ESSAP
J. Payne, ORISE/ESSAP
File/606

CONFIRMATORY SURVEY OF THE PHASE I UNAFFECTED AREAS KERR-McGEE CORPORATION, CIMARRON FACILITY CRESCENT, OKLAHOMA

[DOCKET 70-0925]

J. L. PAYNE

Prepared for the
Division of Waste Management
U.S. Nuclear Regulatory Commission
Headquarters Office

ORISE

OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Division

The Oak Ridge Institute for Science and Education (ORISE) was established by the U.S. Department of Energy to undertake national and international programs in science and engineering education, training and management systems, energy and environment systems, and medical sciences. ORISE and its programs are operated by Oak Ridge Associated Universities (ORAU) through a management and operating contract with the U.S. Department of Energy. Established in 1946, ORAU is a consortium of 82 colleges and universities.

NOTICES

The opinions expressed herein do not necessarily reflect the opinions of the sponsoring institutions of Oak Ridge Associated Universities.

This report was prepared as an account of work sponsored by the United States Government. Neither the United States Government nor the U.S. Department of Energy, nor any of their employees, makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe on privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement or recommendation, or favor by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

CONFIRMATORY SURVEY OF THE PHASE I UNAFFECTED AREAS KERR-McGEE CORPORATION, CIMARRON FACILITY CRESCENT, OKLAHOMA

Prepared by

J. L. Payne

Environmental Survey and Site Assessment Program
Environmental and Health Sciences Division
Oak Ridge Institute for Science and Education
Oak Ridge, Tennessee 37831-0117

Prepared for the
Division of Waste Management
U.S. Nuclear Regulatory Commission
Headquarters Office

MARCH 1996

FINAL REPORT

This report is based on work performed under an Interagency Agreement (NRC Fin. No. A-9076) between the U.S. Nuclear Regulatory Commission and the U.S. Department of Energy. Oak Ridge Institute for Science and Education performs complementary work under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

CONFIRMATORY SURVEY
OF THE PHASE I UNAFFECTED AREAS
KERR-McGEE CORPORATION, CIMARRON FACILITY
CRESCENT, OKLAHOMA

Prepared by: James L. Payne Date: 3/12/96
J. L. Payne, Field Survey Team Leader
Environmental Survey and Site Assessment Program

Reviewed by: Mak Laudeman Date: 3/6/96
M. J. Laudeman, Radiochemistry Laboratory Supervisor
Environmental Survey and Site Assessment Program

Reviewed by: Ann T Payne Date: 3/6/96
A. T. Payne, Administrative Services Manager
Safety and Quality Assurance Officer
Environmental Survey and Site Assessment Program

Reviewed by: Eric W. Abelquist Date: 3/12/96
E. W. Abelquist, Assistant Program Director
Environmental Survey and Site Assessment Program

Reviewed by: W L Beck Date: 3/11/96
W. L. Beck, Program Director
Environmental Survey and Site Assessment Program

ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

FIELD STAFF

T. D. Herrera
A. L. Mashburn

LABORATORY STAFF

R. D. Condra
J. S. Cox
M. J. Laudeman
S. T. Shipley

CLERICAL STAFF

T. S. Fox
K. E. Waters

ILLUSTRATOR

T. D. Herrera

TABLE OF CONTENTS

PAGE

List of Figures ii

List of Tables iii

Abbreviations and Acronyms iv

Introduction and Site History 1

Site Description 2

Objectives 2

Document Review 2

Procedures 2

Findings and Results 4

Comparison of Results with Guidelines 5

Summary 5

References 20

Appendices:

Appendix A: Major Instrumentation

Appendix B: Survey and Analytical Procedures

Appendix C: Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

LIST OF FIGURES

PAGE

FIGURE 1: Location of the Cimarron Facility, Crescent, Oklahoma 6

FIGURE 2: Plot Plan of the Cimarron Facility - Phase I Areas Showing Grid Blocks Surveyed 7

FIGURE 3: Unaffected Area A, Grid 200S,0E—Measurement and Sampling Locations 8

FIGURE 4: Unaffected Area A, Grid 400S,300E— Measurement and Sampling Locations 9

FIGURE 5: Unaffected Area B, Grid 300N,800E—Measurement and Sampling Locations 10

FIGURE 6: Unaffected Area B, Grid 500N,1200E—Measurement and Sampling Locations 11

FIGURE 7: Unaffected Area C, Grid 900N,1000E—Measurement and Sampling Locations 12

FIGURE 8: Unaffected Area C, Grid 800N,400E—Measurement and Sampling Locations 13

FIGURE 9: Unaffected Area D, Grid 900N,200E—Measurement and Sampling Locations 14

FIGURE 10: Unaffected Area D, Grid 600N,100E—Measurement and Sampling Locations 15

FIGURE 11: Unaffected Area E, Grid 800N,100W—Measurement and Sampling Locations 16

FIGURE 12: Unaffected Area E, Grid 500N,200W—Measurement and Sampling Locations 17

LIST OF TABLES

PAGE

TABLE 1: Exposure Rates and Uranium Concentrations in Soil Samples 18

ABBREVIATIONS AND ACRONYMS

µR/h	microroentgens per hour
µrem/h	microrem per hour
AEC	Atomic Energy Commission
ASME	American Society of Mechanical Engineers
cm	centimeter
D&D	decontamination and decommissioning
DOE	Department of Energy
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
GPS	Global Positioning System
kg	kilogram
km	kilometer
KMC	Kerr-McGee Corporation
m	meter
MDC	minimum detectable concentration
MOFF	Mixed Oxide Fuel Fabrication
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
SFC	Sequoyah Fuels Corporation
U-Plant	Uranium Fuel Fabrication Facility

CONFIRMATORY SURVEY
OF THE
PHASE I UNAFFECTED AREAS
KERR-McGEE CORPORATION, CIMARRON FACILITY
CRESCENT, OKLAHOMA

INTRODUCTION AND SITE HISTORY

The Kerr-McGee Corporation (KMC) operated two plants at the Cimarron Facility between 1965 and 1975 under two Atomic Energy Commission (AEC) licenses. License SNM-928 was issued in 1965 for the Uranium Fuel Fabrication (U-Plant) Facility and license SNM-1174 was issued in 1970 for the Mixed Oxide Fuel Fabrication (MOFF) Facility. In 1983, Sequoyah Fuels Corporation (SFC) became the owner of the Cimarron Facility, when KMC was divided into SFC and Quivira Mining Corporation. Subsequently, Cimarron Corporation, a subsidiary of KMC, became responsible for the Cimarron Facility.

The decontamination and decommissioning (D&D) work began in 1976. D&D activities at the MOFF Facility were completed in 1990. KMC applied to the Nuclear Regulatory Commission (NRC), formerly the AEC, on August 20, 1990 for the termination of license SNM-1174 and it was terminated on February 5, 1993. However, the NRC did not release the land formerly licensed under SNM-1174 and contained within the bounds of the Cimarron Facility and license SNM-928. A large portion of the land contained within the bounds of license SNM-928 was divided into five areas totaling approximately 240 hectares (Cimarron 1995).

KMC had no evidence that would suggest that radioactive materials were disposed of in any of these five areas during nuclear fuel fabrication operations and/or subsequent decommissioning activities. Therefore, KMC classified the areas (A,B,C,D, and E) as unaffected and refers to them as the Phase I unaffected areas in their final status survey report (Cimarron 1995). Unaffected areas are defined as those areas that are not expected to contain residual contamination.

It is the policy of the NRC to perform confirmatory surveys of facilities that have undergone decommissioning and have requested NRC license termination. The NRC's Division of Waste Management requested that the Environmental Survey and Site Assessment Program

(ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) conduct a confirmatory survey of the land areas designated as the Phase I unaffected areas at the Cimarron Corporation Facility in Crescent, Oklahoma. This report describes the results of the survey.

SITE DESCRIPTION

The Cimarron Facility is located approximately 8 kilometers (km) south of the city of Crescent, Oklahoma and approximately 0.8 km north of the intersection of Oklahoma State Highways #33 and #74 in Logan County (Figure 1). The terrain of the region is rolling pasture land. Site elevations range from 286 to 309 meters above sea level. The entire Cimarron site encompasses approximately 340 hectares. The total size of the five unaffected areas, which consist of mostly pastureland and newly planted winter wheat fields, is approximately 240 hectares. The respective land areas for the unaffected areas A, B, C, D, and E are approximately 64, 56, 46, 18, and 59 hectares (Figure 2).

OBJECTIVES

The objectives of the confirmatory survey were to provide independent document reviews and radiological data for use by the NRC in evaluating the adequacy and accuracy of the licensee's procedures and radiological survey results.

DOCUMENT REVIEW

ESSAP reviewed the licensee's survey report on the Phase I unaffected areas of the Cimarron Facility (Cimarron 1995). Procedures and methods utilized by the licensee were reviewed for adequacy and appropriateness. The data were reviewed for accuracy, completeness, and compliance with guidelines.

PROCEDURES

During the period October 17 through 19, 1995, an ESSAP team visited the Cimarron Facility and performed visual inspections, gamma scans, exposure rate measurements, and soil sampling of the Phase I unaffected areas. Surveys were performed in accordance with a survey plan dated October 10, 1995, submitted to and approved by the NRC (ORISE 1995a).

REFERENCE GRID

ESSAP randomly selected two 100 m x 100 m grid blocks in each of the five Phase I areas for measurement and sampling (Figure 2). The corners of each grid block selected were re-established by KMC using a global positioning system (GPS). Measurement and sampling locations were also referenced in each grid block by this method. In this report, individual grid blocks were referenced according to the southwest grid intersection coordinate.

SURFACE SCANS

Surface scans for gamma radiation were performed over 75 to 100% of the area in each grid block selected (2 blocks per area). Particular attention was given to areas adjacent to site access roads, natural drainage pathways, and other areas where material may have accumulated. Scans were performed using NaI scintillation detectors coupled to ratemeters with audible indicators.

EXPOSURE RATE MEASUREMENTS

Background exposure rates were performed at six locations within a 0.5 to 10 km radius of the site during a previous ESSAP survey (ORISE 1995b). Site exposure rate measurements were performed at each soil sample location at 1 m above the surface using a microrem meter (Figures 3 through 12).

SOIL SAMPLING

Background soil samples were collected from each location of background exposure rate measurement during a previous ESSAP survey (ORISE 1995b). Three surface (0-15 cm) soil

samples were collected from randomly selected locations in each grid block (Figures 3 through 12). Due to uncertainties in sampling locations because the GPS was unavailable to establish exact grid block corners, one sample location is not within the selected grid block (Figure 3). The GPS was used to identify grid block corners and exact sample locations for all other grids selected.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Soil samples were analyzed by gamma spectrometry. The radionuclides of interest were U-235 and U-238; however, spectra were reviewed for other identifiable photopeaks. Gamma spectrometry data were reported in units of picocuries per gram (pCi/g). Exposure rate measurements were reported in units of microroentgens per hour (μR/h). Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared to the licensee's documentation and NRC guidelines established for release to unrestricted use, provided in Appendix C.

FINDINGS AND RESULTS

SURFACE SCANS

Surface scans for gamma activity in the 10 randomly selected grid blocks did not identify any locations of elevated direct radiation.

EXPOSURE RATES

Background exposure rates at 1 m above the surface, measured on a previous ESSAP site survey, ranged from 6 to 8 μR/h, with an average of 7 μR/h. Exposure rates at the 30 surface soil sampling locations are presented in Table 1 and ranged from 4 to 12 μR/h.

URANIUM CONCENTRATIONS IN SOIL

Uranium concentrations in background soil samples, collected during a previous ESSAP site survey, ranged from 0.8 to 2.3 pCi/g for total uranium. Uranium concentrations in soil samples collected from the Phase I unaffected areas are summarized in Table 1. Concentrations were all less than 0.1 pCi/g for U-235, were less than or equal to 2.5 pCi/g for U-238, and were all less than 4.6 pCi/g for total uranium.

COMPARISON OF RESULTS WITH GUIDELINES

The primary contaminant of concern for this site is enriched uranium. The generic guidelines for residual concentrations of uranium in soil are provided in the Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations" (USNRC 1981). Specifically, the Option 1 average soil guideline for enriched uranium is 30 pCi/g. Total uranium concentrations in all of the surface soil samples collected from the Phase I unaffected areas were at levels consistent with natural background and therefore, below the average guideline level.

The exposure rate guideline, measured at 1 m from the surface, is 10 μR/h above background. Exposure rates measured in the Phase I areas were all within this guideline.

SUMMARY

During the period October 17 through 19, 1995, the Environmental Survey and Site Assessment Program of ORISE performed a confirmatory survey of the Phase I Unaffected Areas at the Kerr-McGee Cimarron Facility in Crescent, Oklahoma. Survey activities included surface scans, exposure rate measurements, and soil sampling.

The ESSAP confirmatory measurements are consistent with the licensee's measurements and support the licensee's conclusion that total uranium concentrations and exposure rates within the Phase I areas satisfies NRC guidelines for release to unrestricted use.

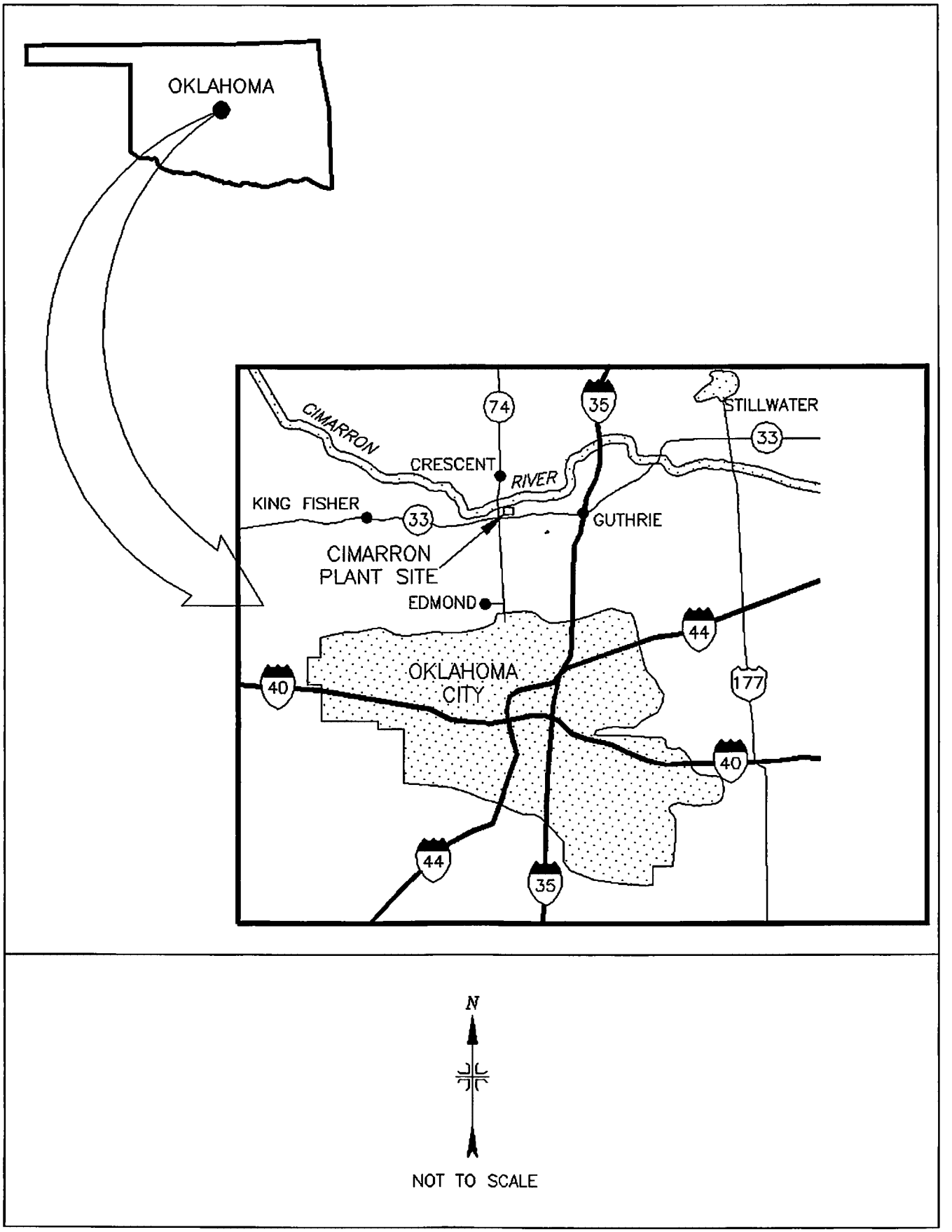
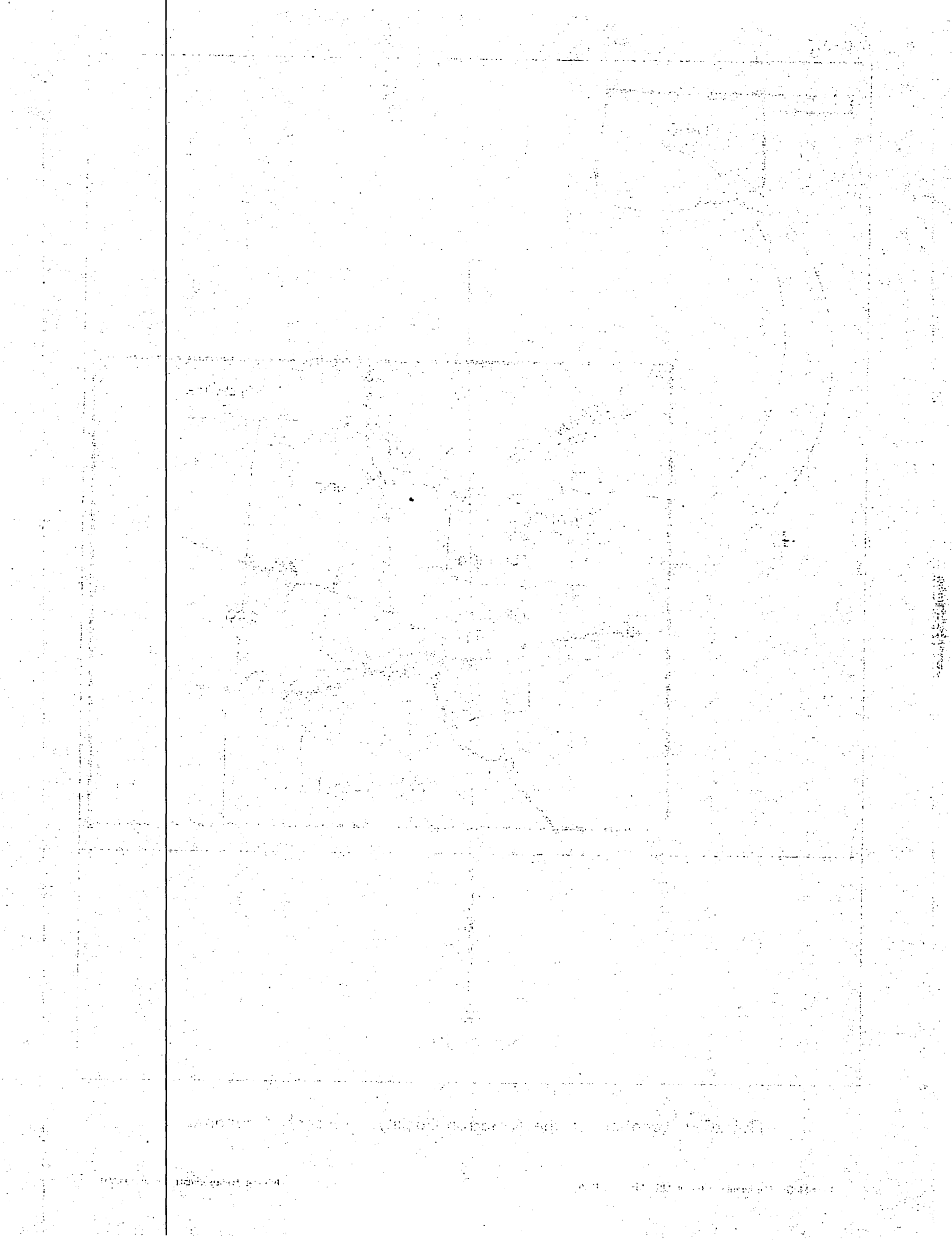


FIGURE 1: Location of the Cimarron Facility, Crescent, Oklahoma



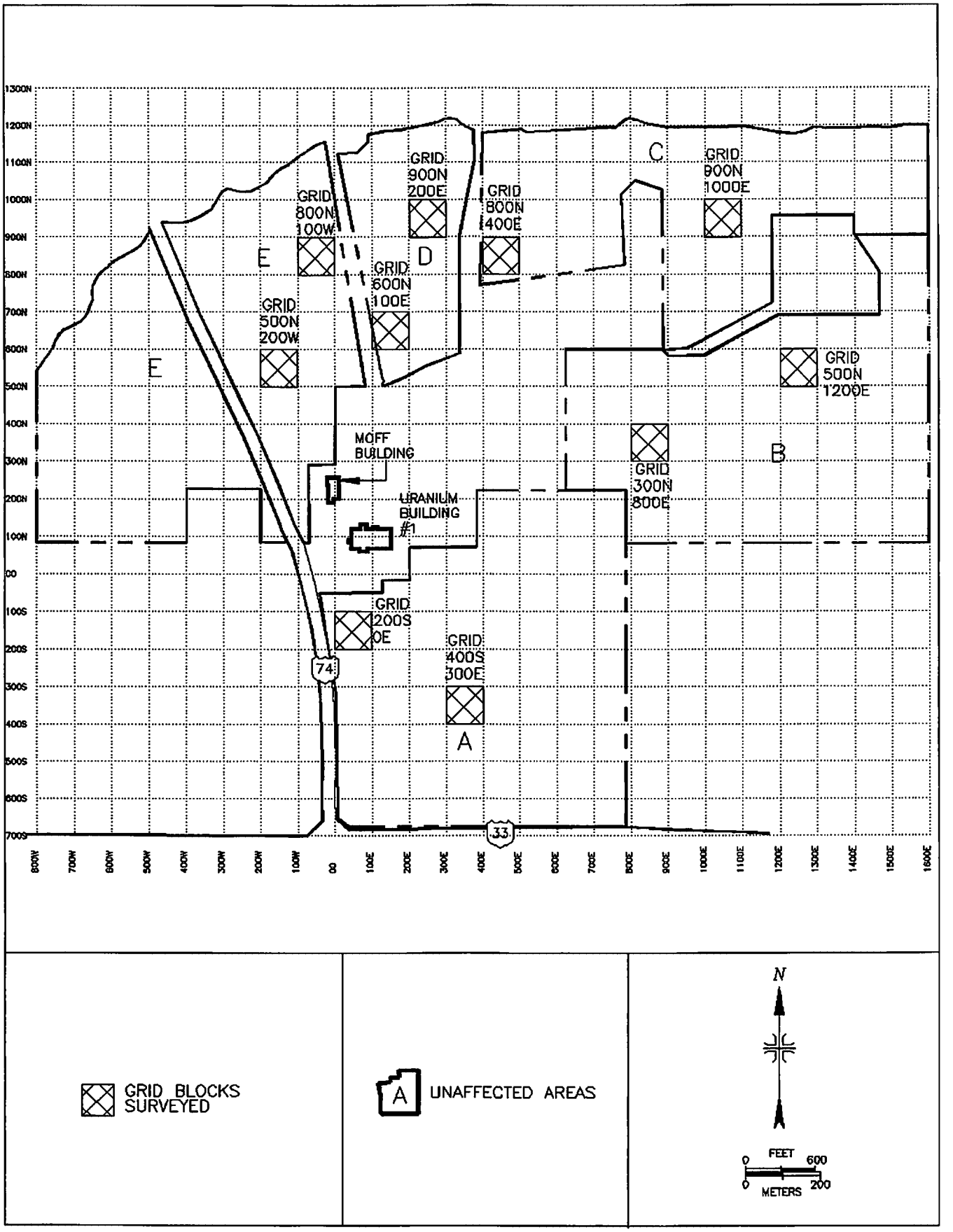
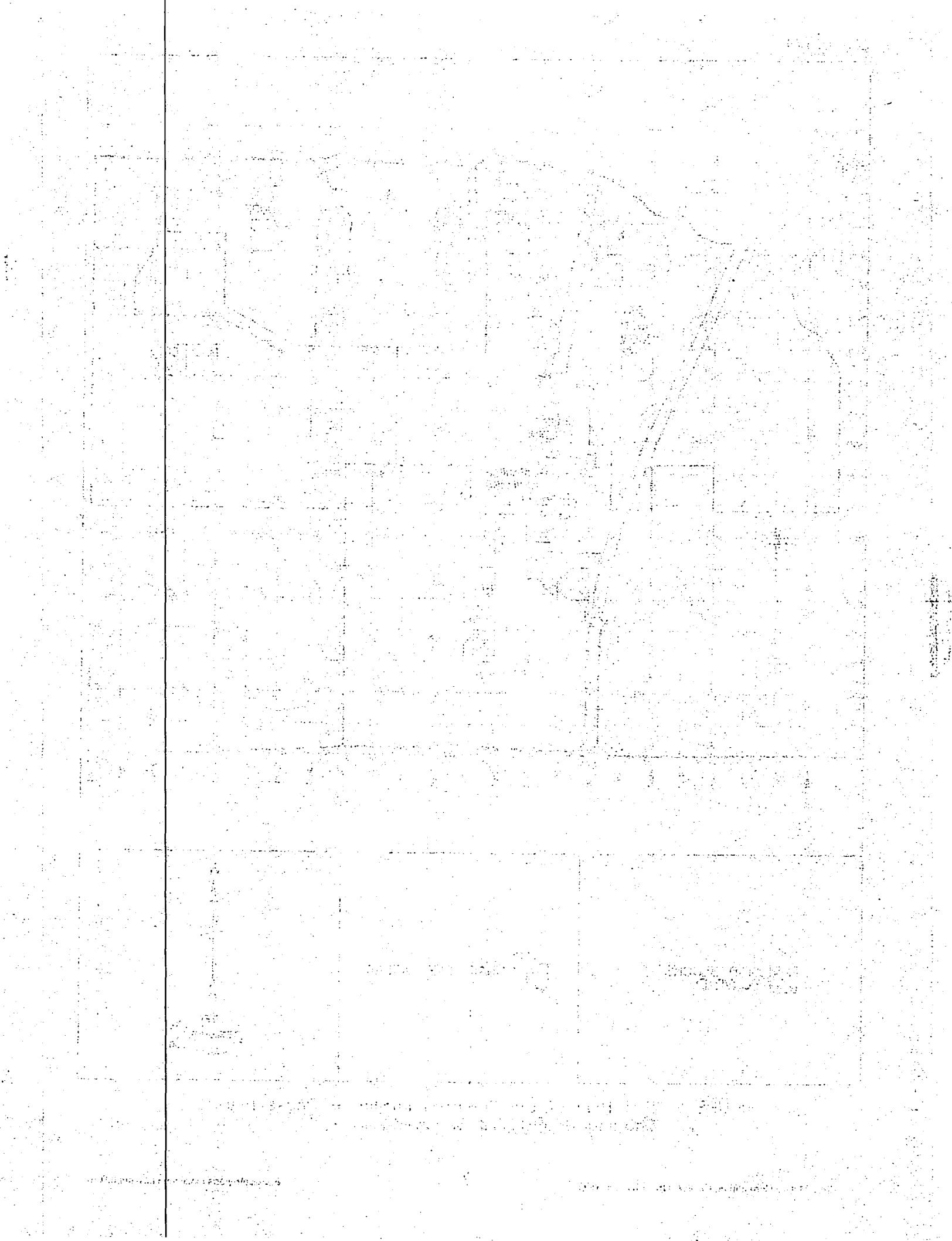


FIGURE 2: Plot Plan of the Cimarron Facility – Phase I Areas Showing Grid Blocks Surveyed



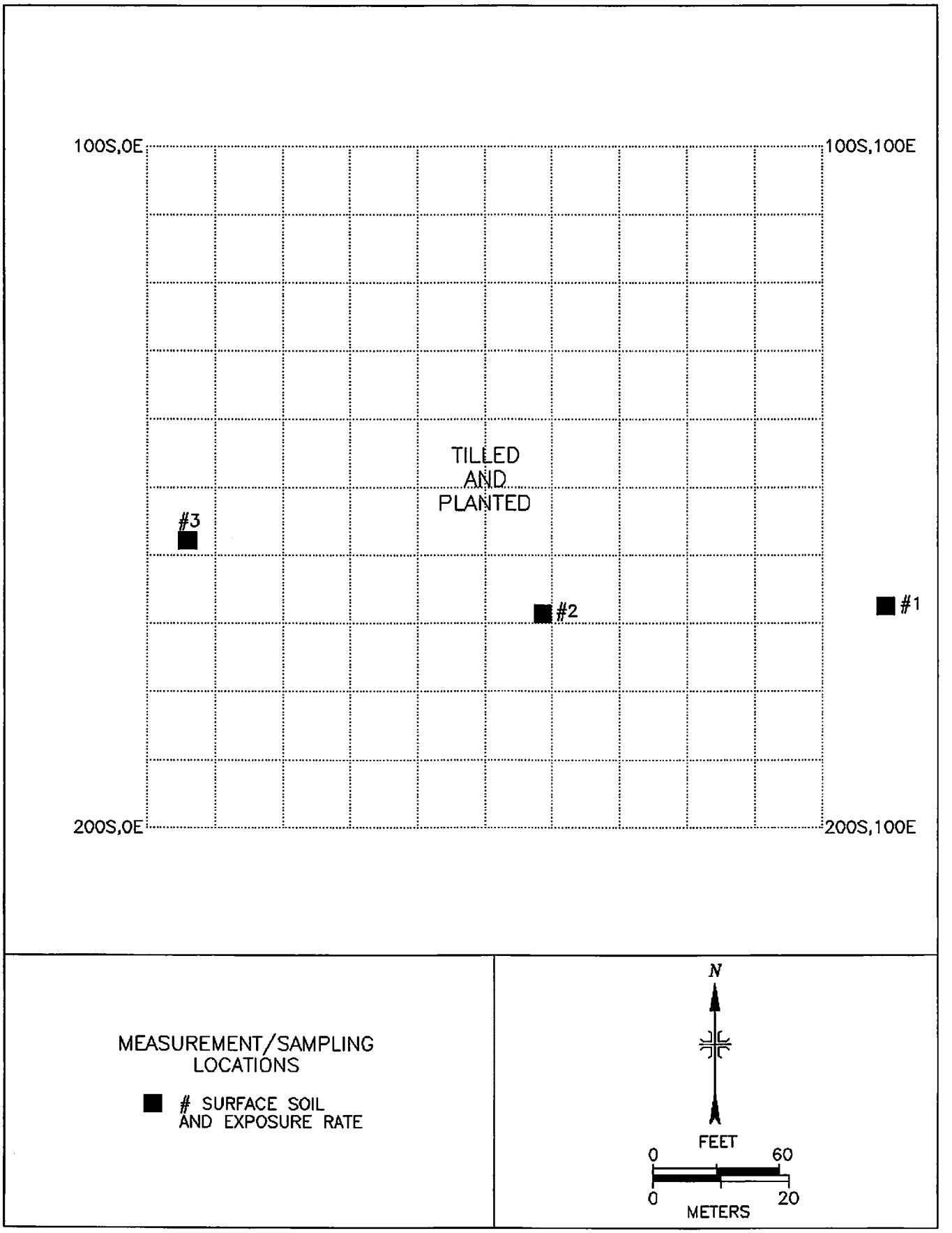


FIGURE 3: Unaffected Area A, Grid 200S,0E – Measurement and Sampling Locations

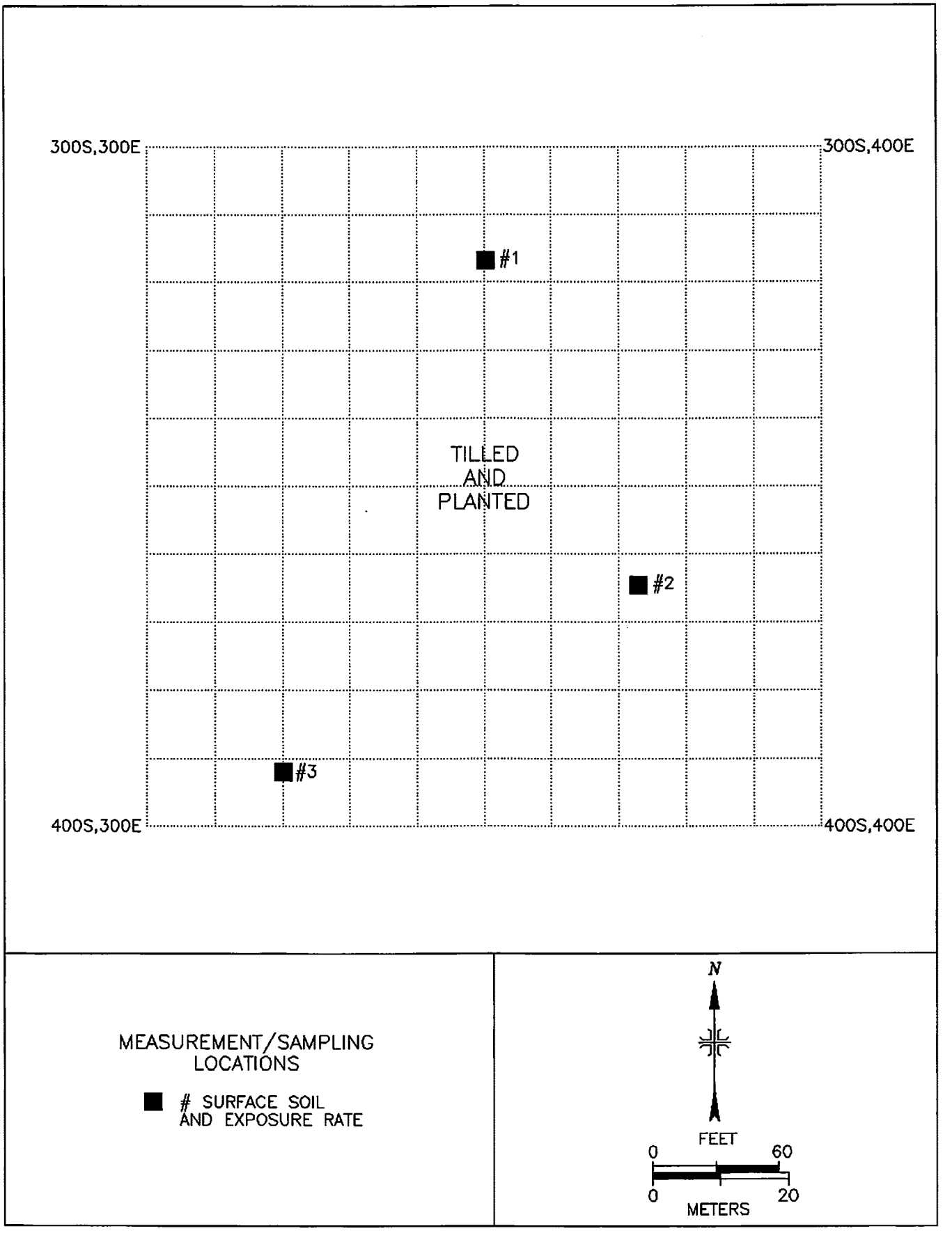
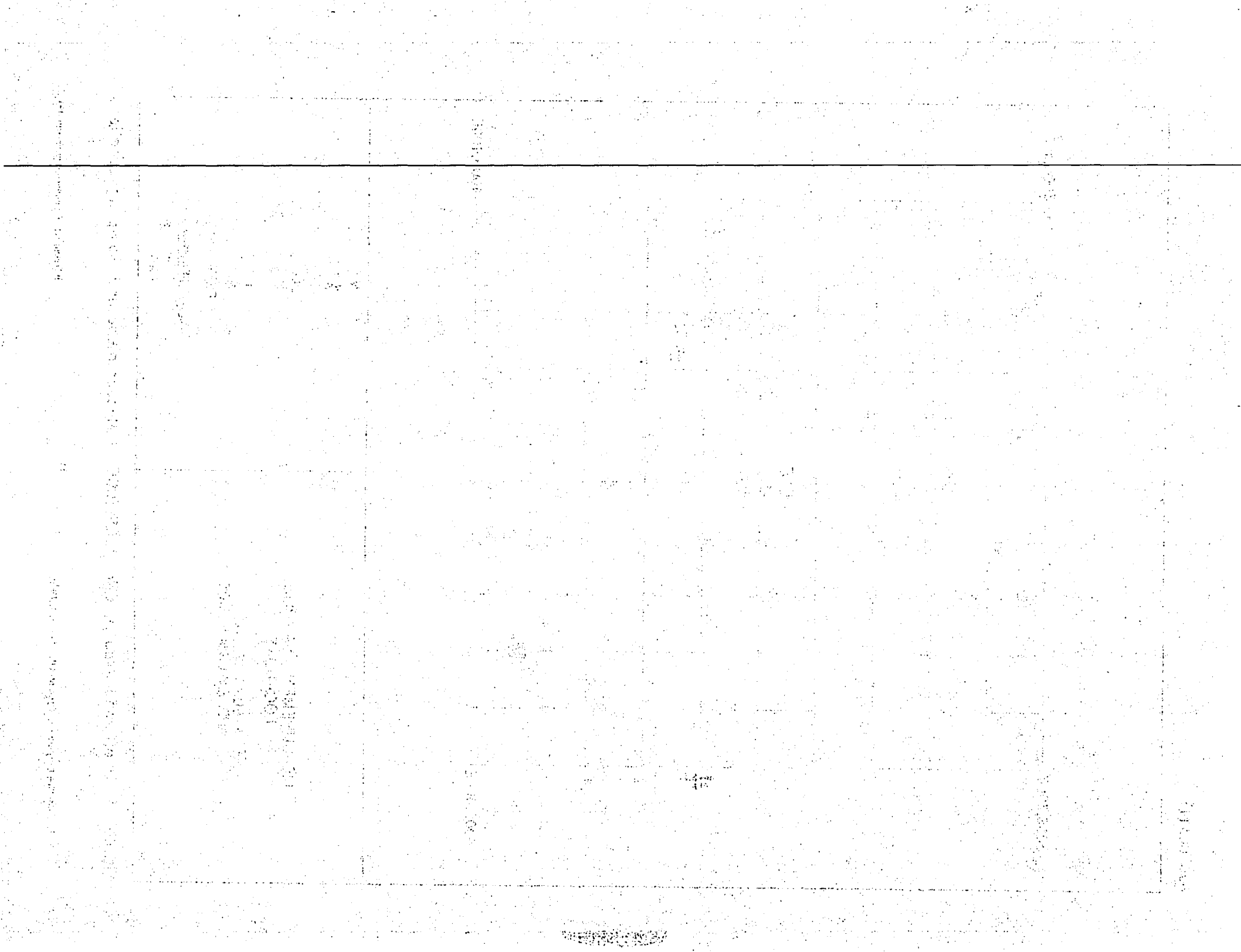


FIGURE 4: Unaffected Area A, Grid 400S,300E – Measurement and Sampling Locations



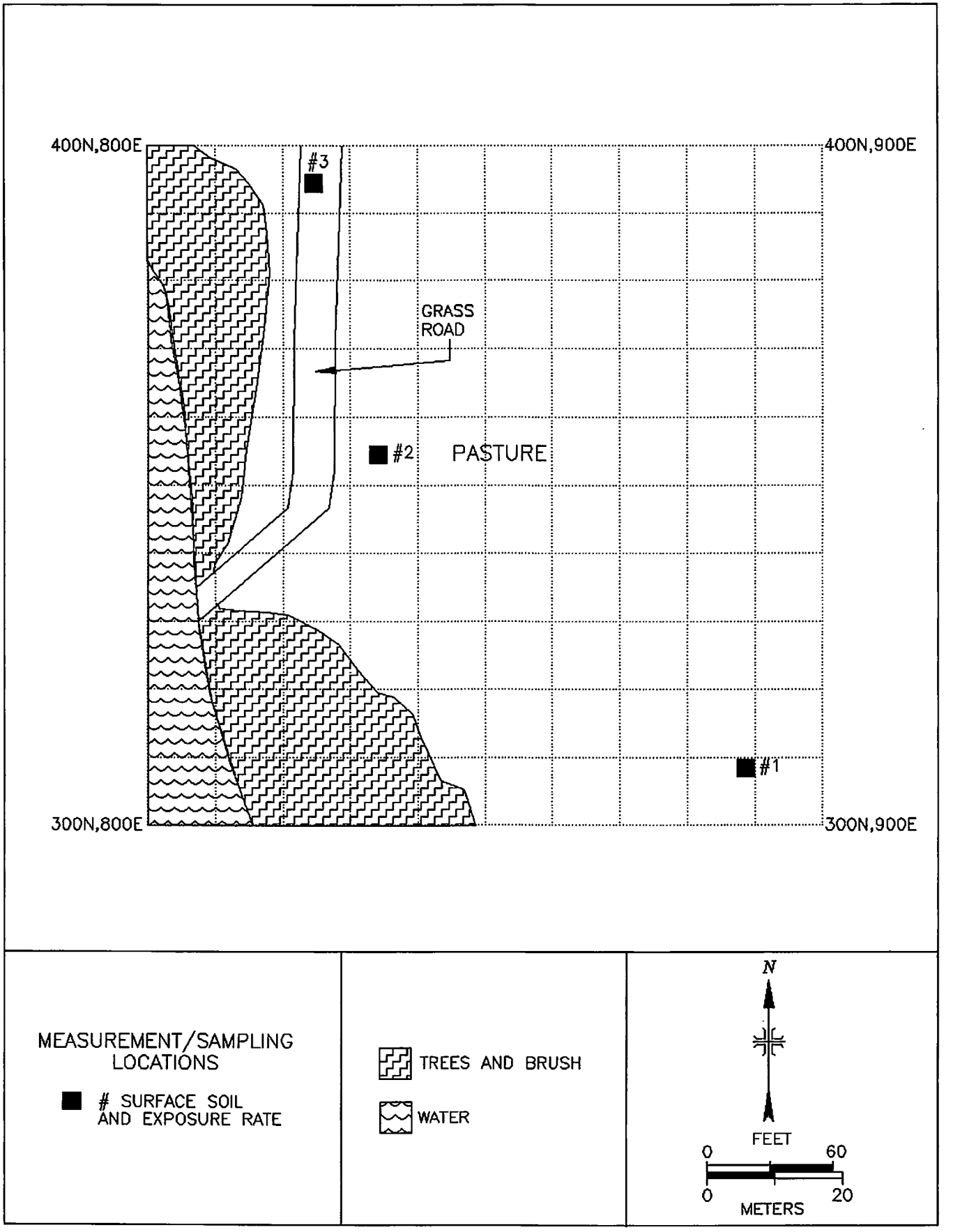
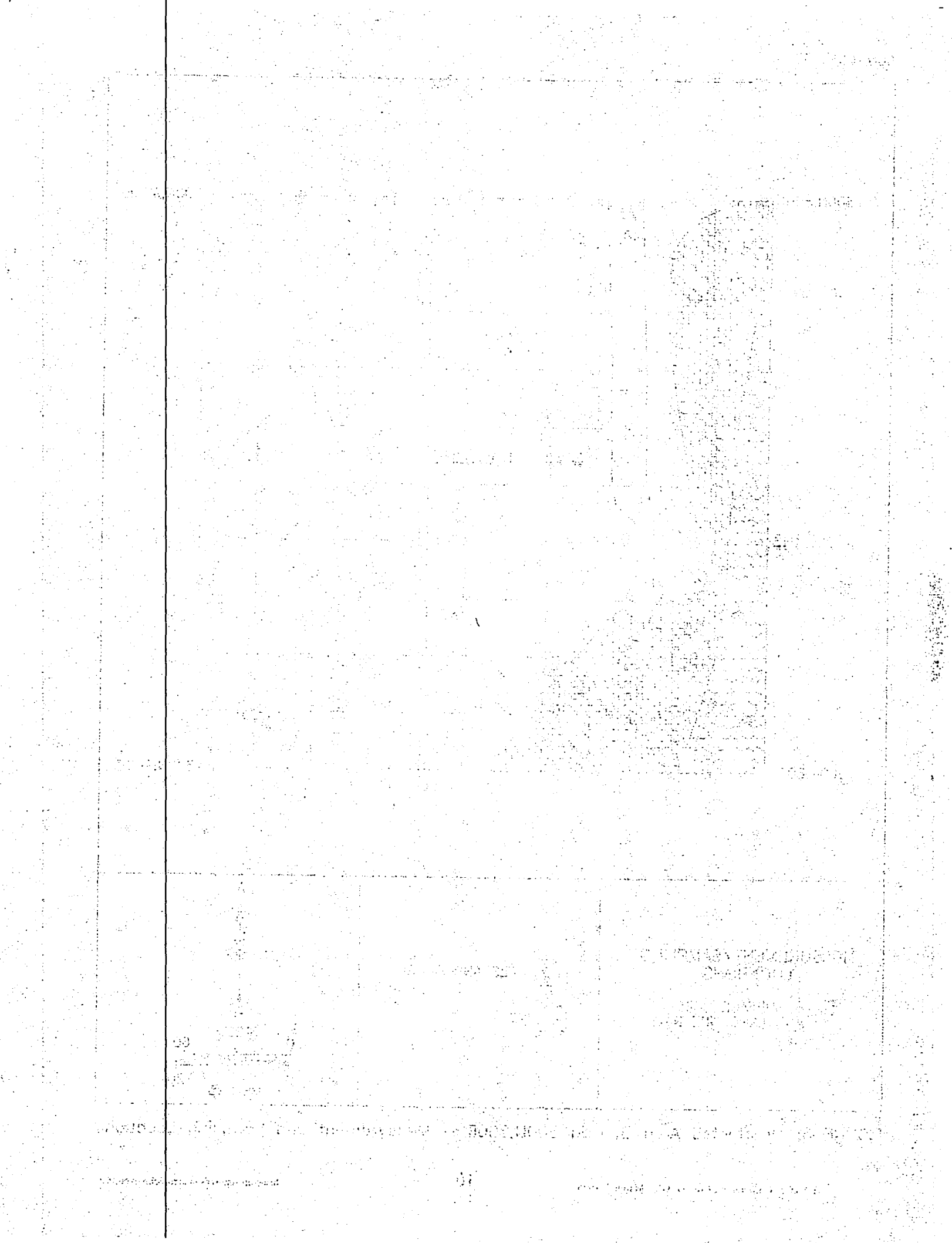


FIGURE 5: Unaffected Area B, Grid 300N,800E – Measurement and Sampling Locations



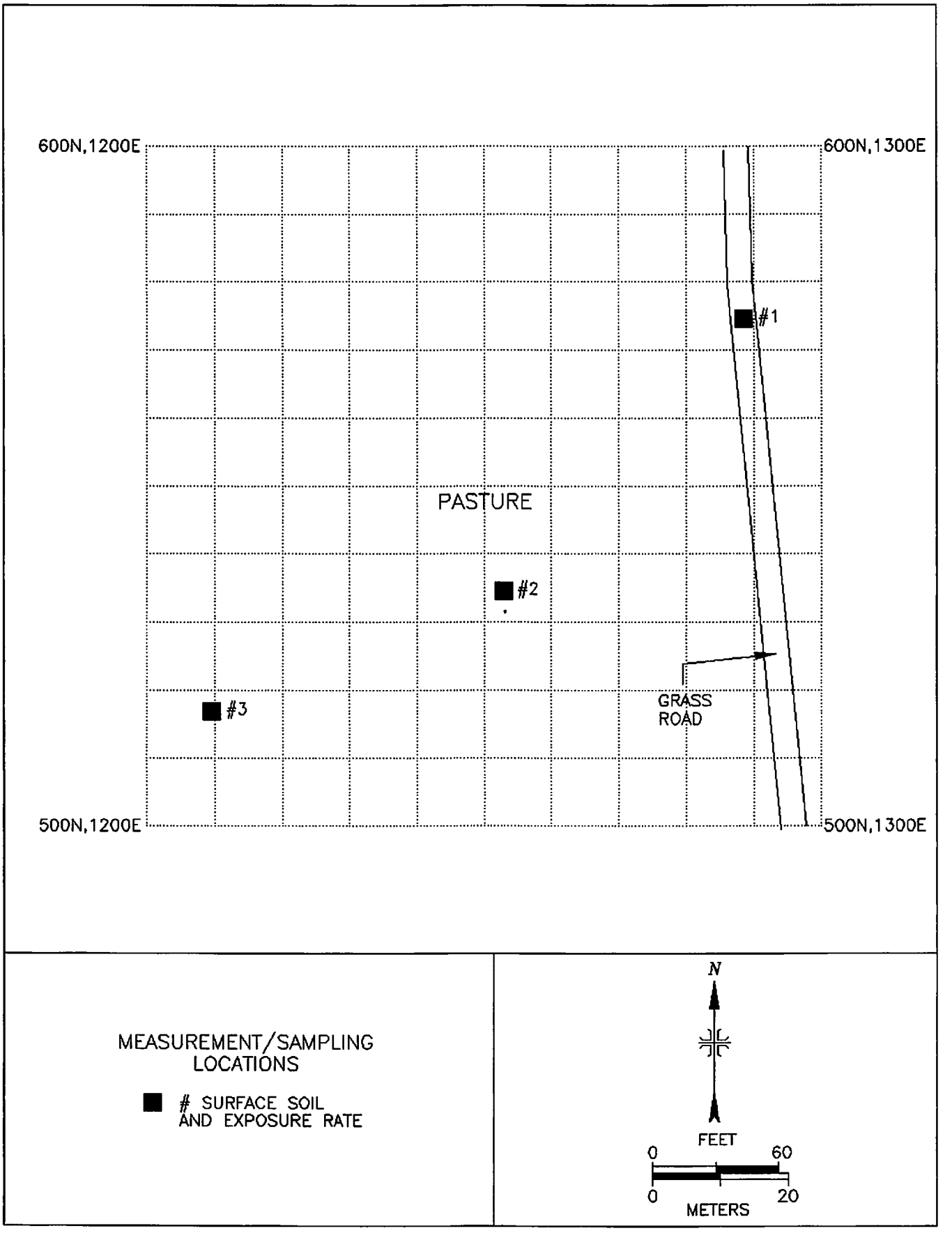
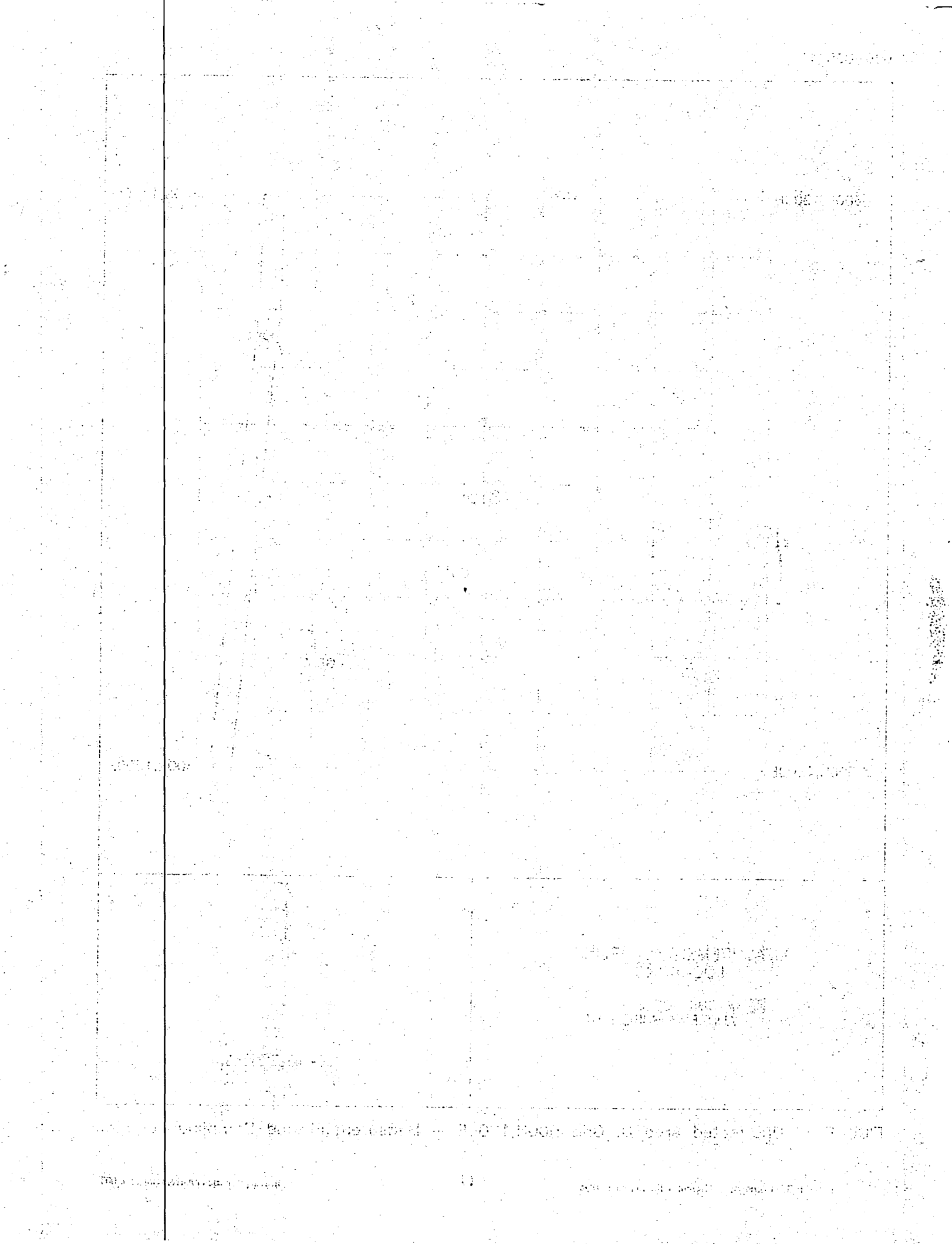


FIGURE 6: Unaffected Area B, Grid 500N,1200E – Measurement and Sampling Locations



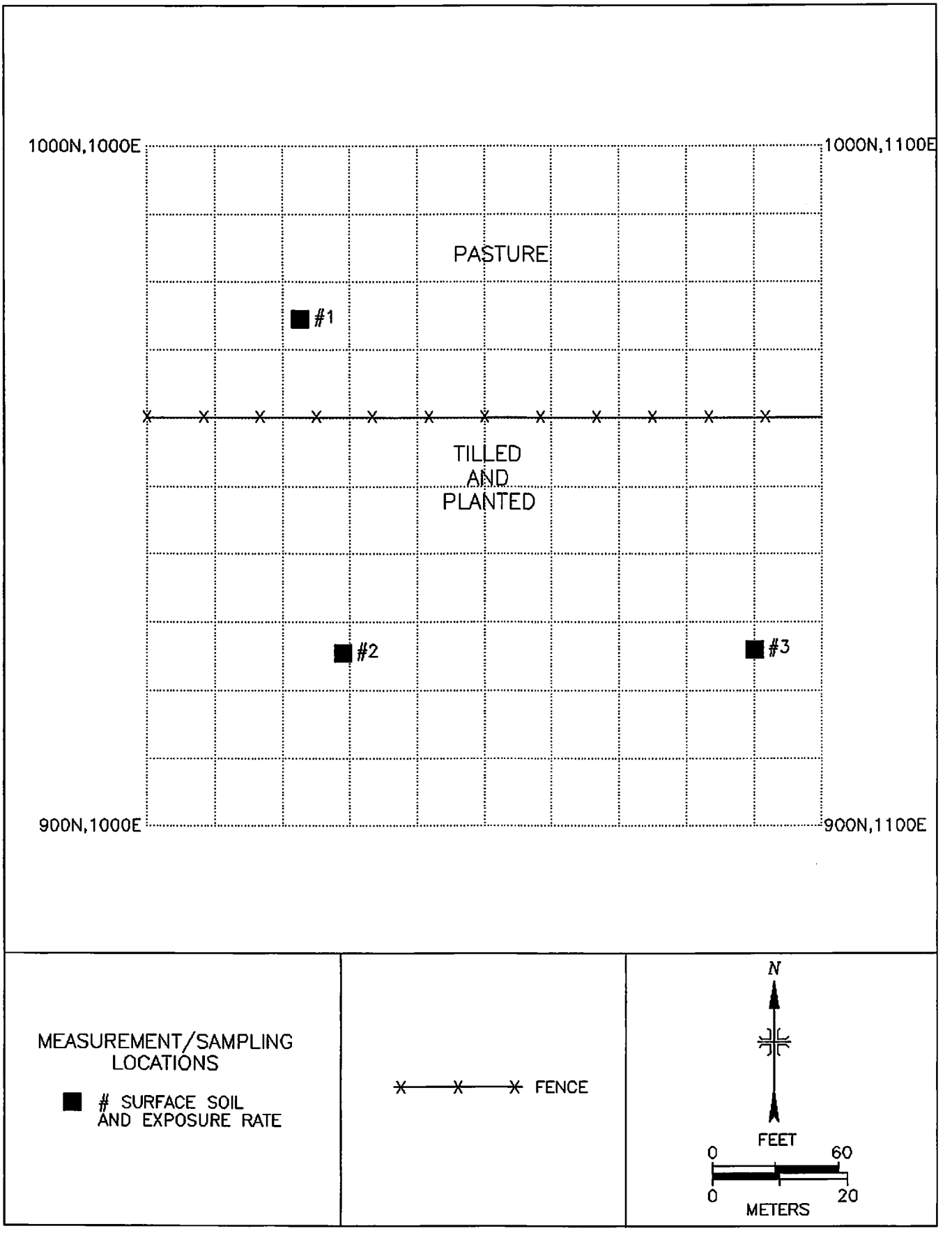


FIGURE 7: Unaffected Area C, Grid 900N,1000E – Measurement and Sampling Locations

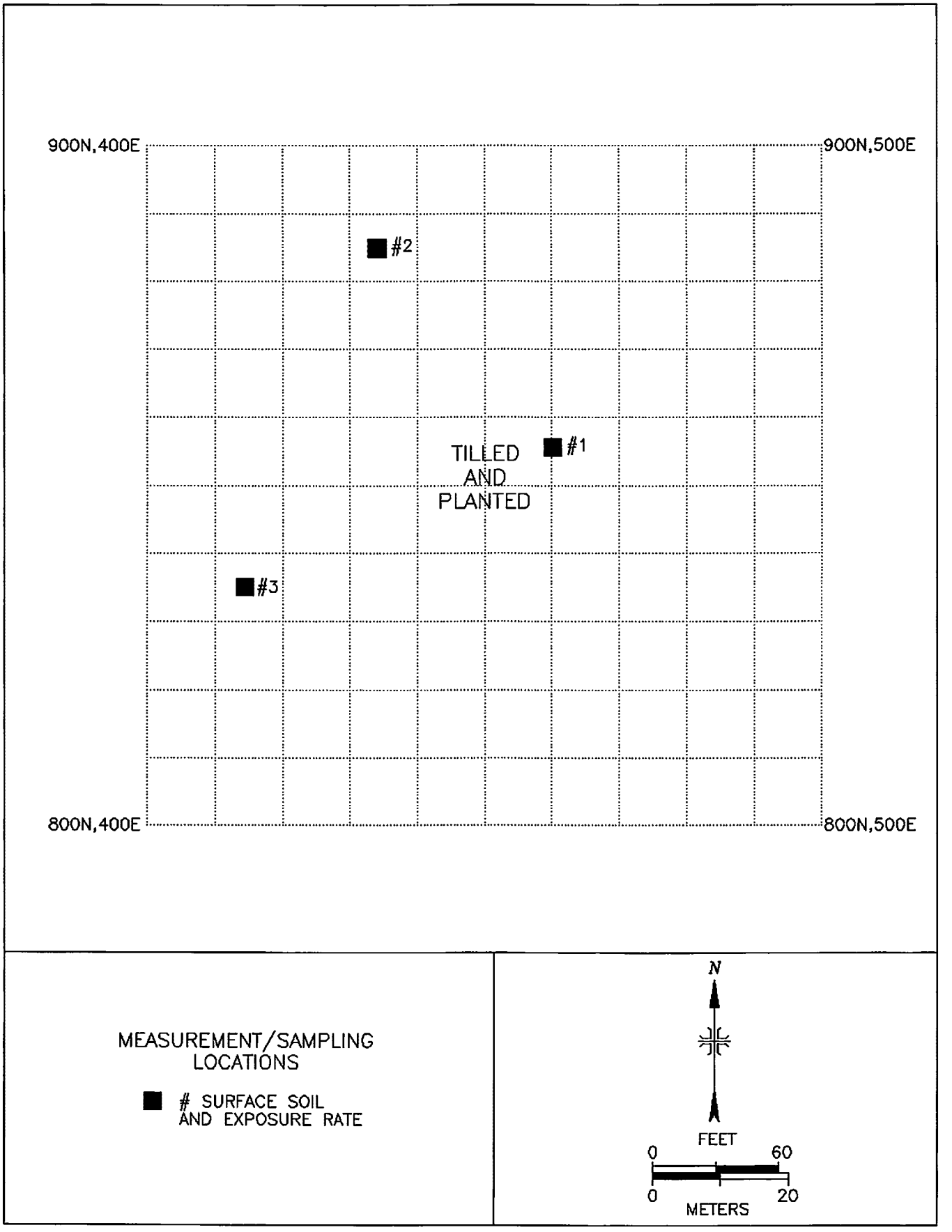


FIGURE 8: Unaffected Area C, Grid 800N,400E – Measurement and Sampling Locations

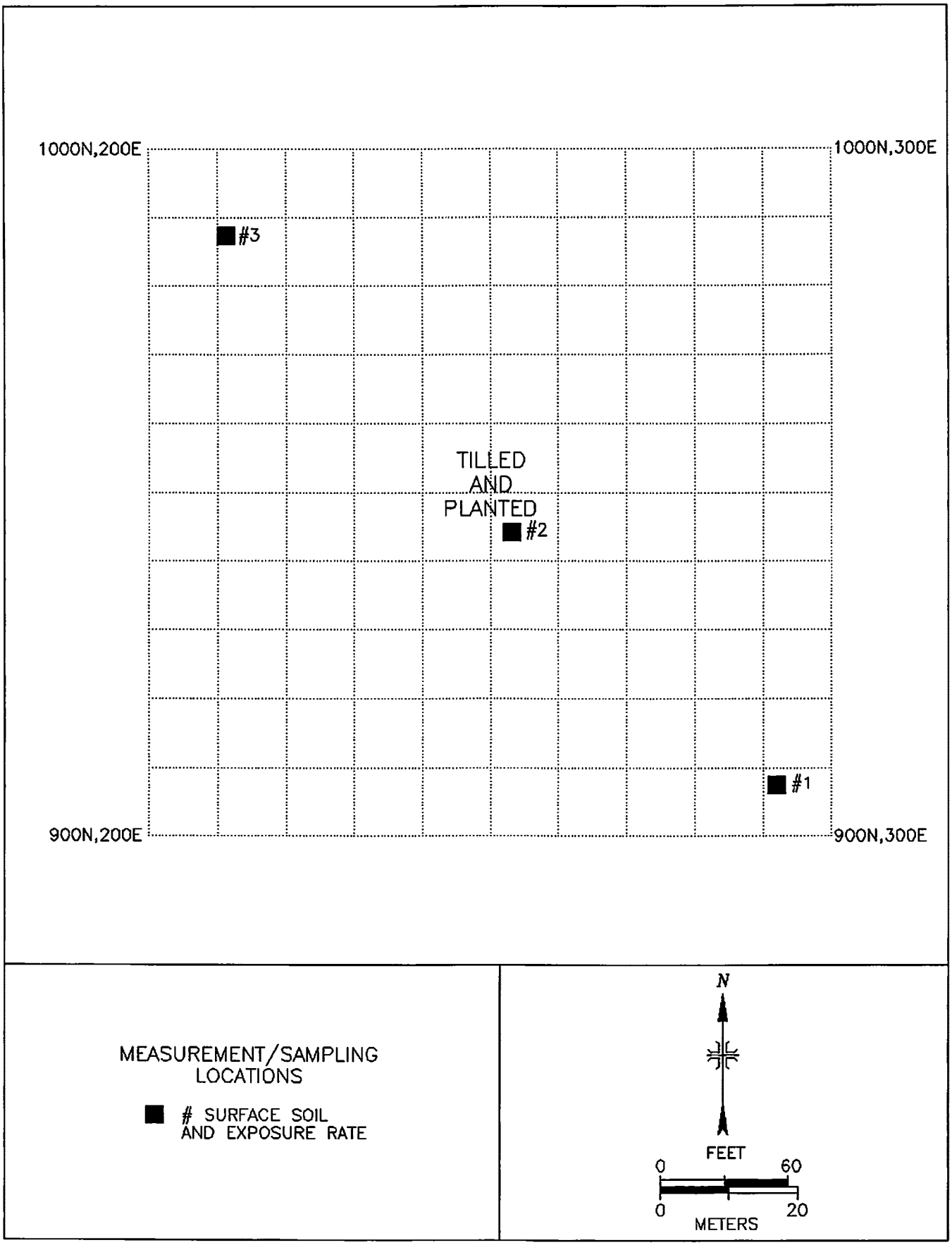
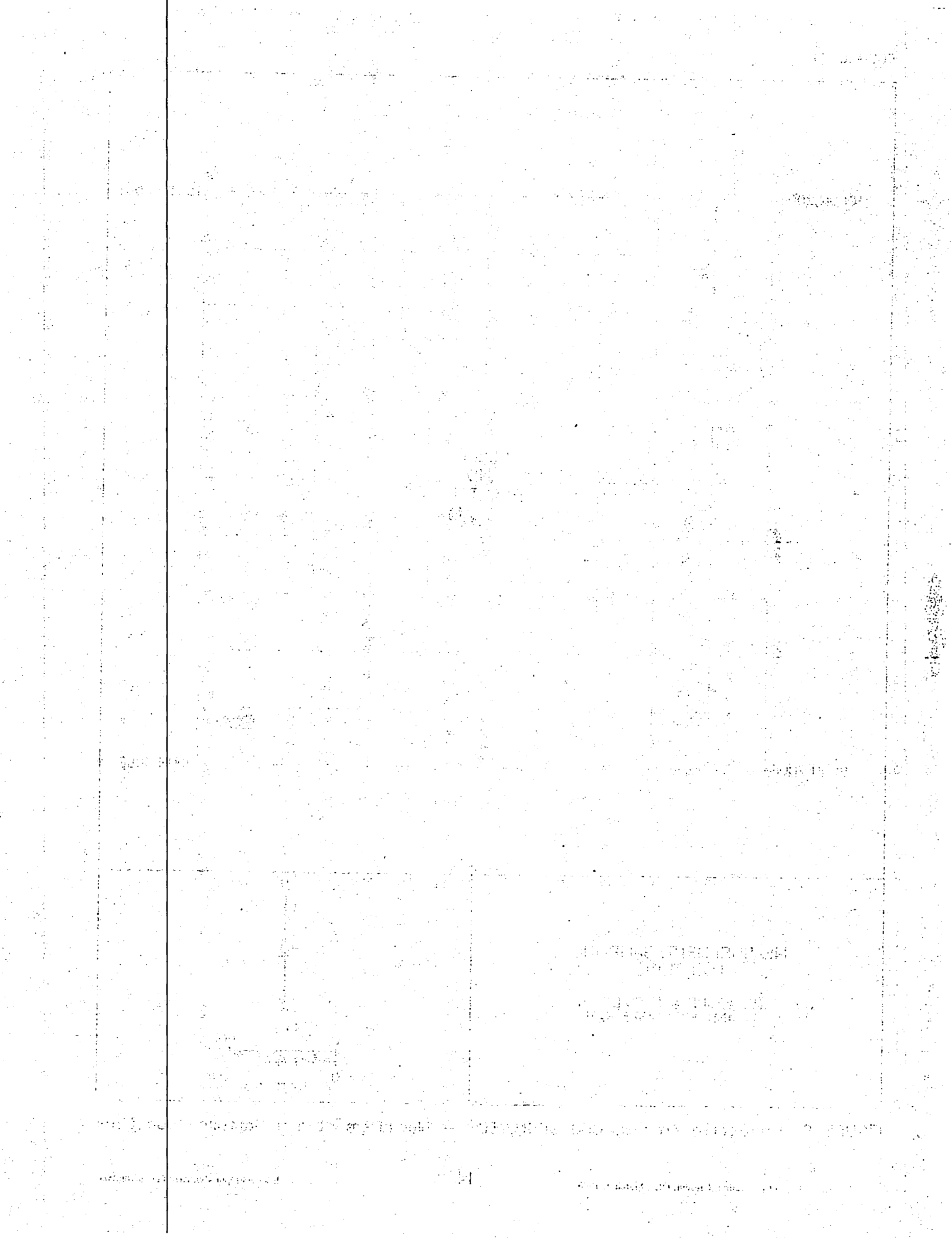


FIGURE 9: Unaffected Area D, Grid 900N,200E – Measurement and Sampling Locations



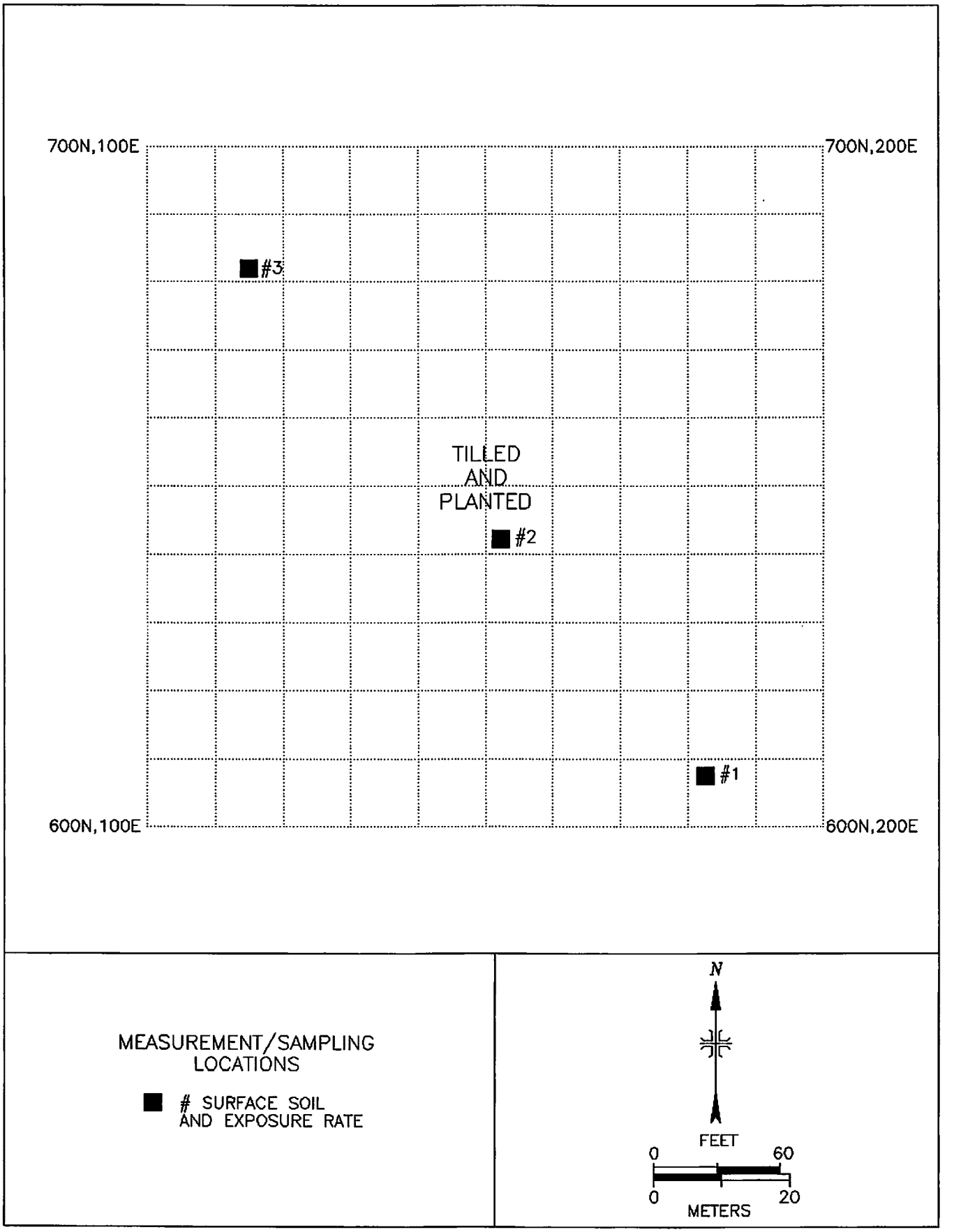


FIGURE 10: Unaffected Area D, Grid 600N,100E – Measurement and Sampling Locations

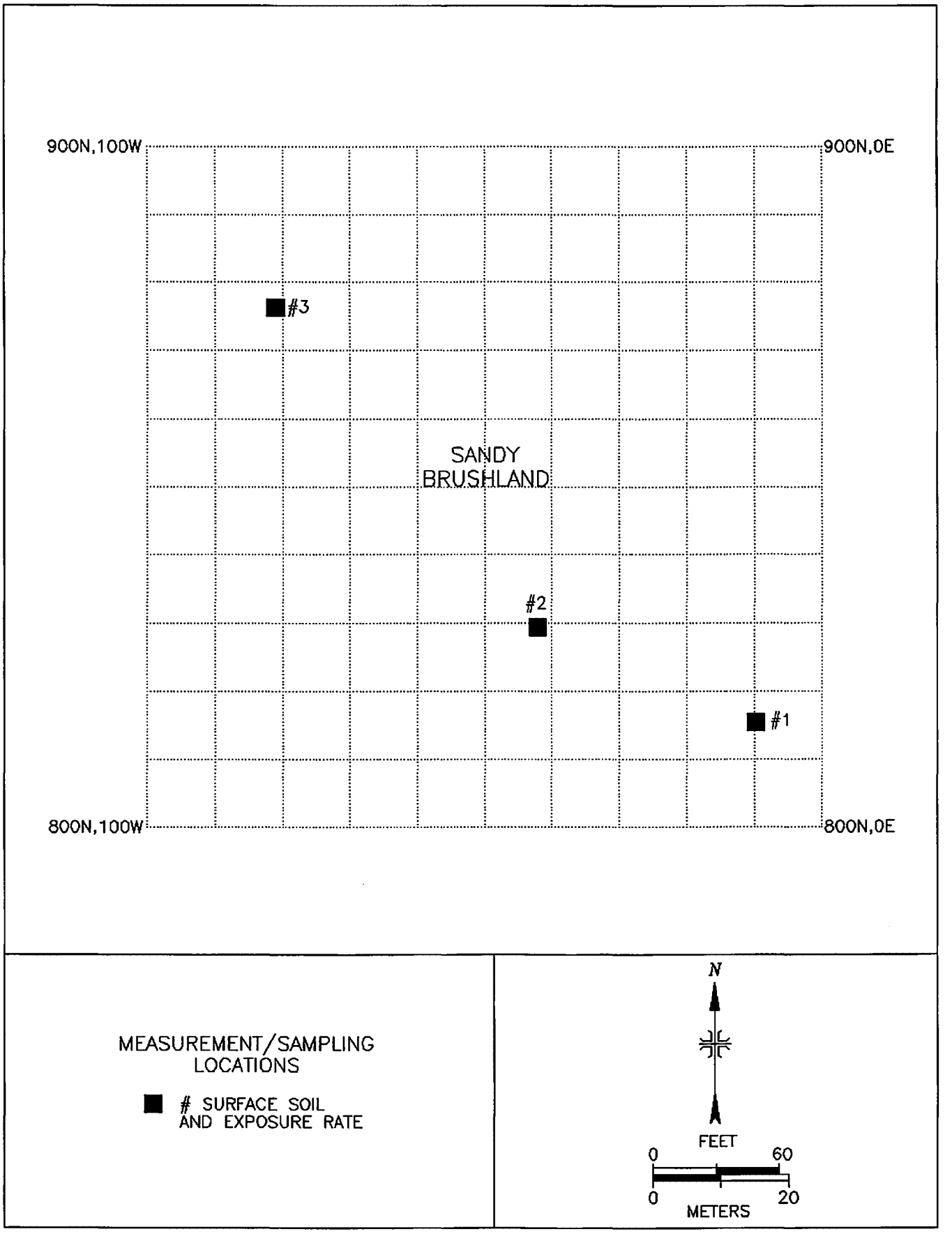


FIGURE 11: Unaffected Area E, Grid 800N,100W – Measurement and Sampling Locations

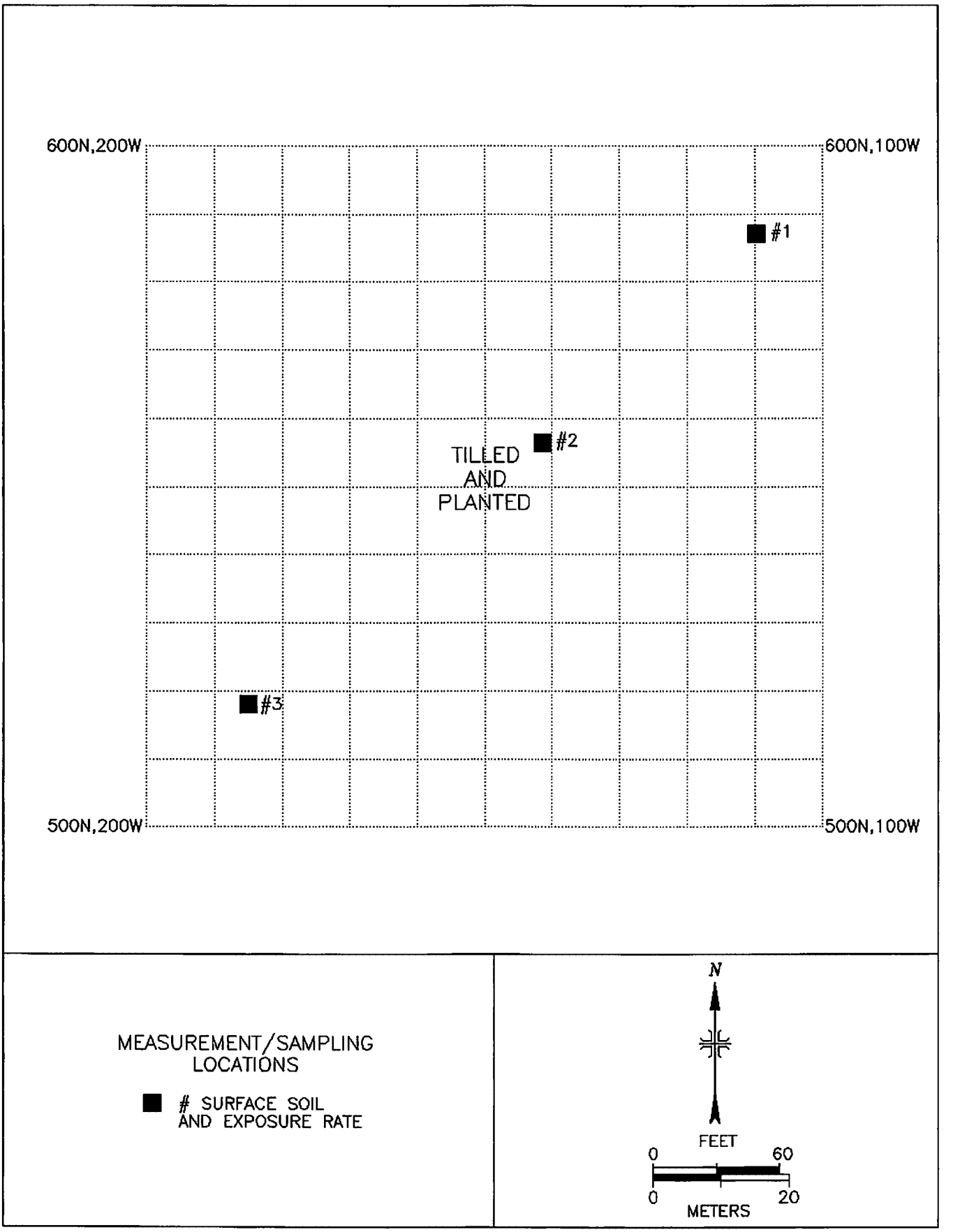


FIGURE 12: Unaffected Area E, Grid 500N,200W – Measurement and Sampling Locations

TABLE 1

EXPOSURE RATES AND URANIUM CONCENTRATIONS IN SOIL SAMPLES FROM PHASE I UNAFFECTED AREAS KERR-McGEE CORPORATION, CIMARRON FACILITY CRESCENT, OKLAHOMA

Location	Exposure Rate at 1 m Above Surface (μR/h)	Uranium Concentrations (pCi/g)		
		U-235	U-238	Total Uranium[a]
Unaffected Area A[b]				
200S 0E, Location #1	7	<0.1	2.4 ± 1.7[c]	<4.5
200S, 0E, Location #2	6	<0.1	2.5 ± 1.6	<4.6
200S, 0E, Location #3	5	<0.1	0.6 ± 0.8	<2.7
400S, 300E, Location #1	7	<0.1	1.4 ± 1.6	<3.5
400S, 300E, Location #2	7	<0.1	0.8 ± 1.4	<2.9
400S, 300E, Location #3	7	<0.1	<1.1	<3.2
Unaffected Area B[d]				
300N, 800E, Location #1	5	<0.1	<1.6	<3.7
300N, 800E, Location #2	5	<0.1	<1.2	<3.3
300N, 800E, Location #3	4	<0.1	<1.5	<3.6
500N, 1200E, Location #1	4	<0.1	<1.5	<3.6
500N, 1200E, Location #2	4	<0.1	1.6 ± 1.3	<3.7
500N, 1200E, Location #3	4	<0.1	1.2 ± 1.0	<3.3
Unaffected Area C[e]				
900N, 1000E, Location #1	4	<0.1	0.9 ± 0.9	<3.0
900N, 1000E, Location #2	9	<0.1	<1.4	<3.5
900N, 1000E, Location #3	12	<0.1	1.7 ± 1.1	<3.8
800N, 400E, Location #1	5	<0.1	0.7 ± 1.1	<2.8
800N, 400E, Location #2	7	<0.1	<1.5	<3.6
800N, 400E, Location #3	7	<0.1	1.1 ± 1.2	<3.2

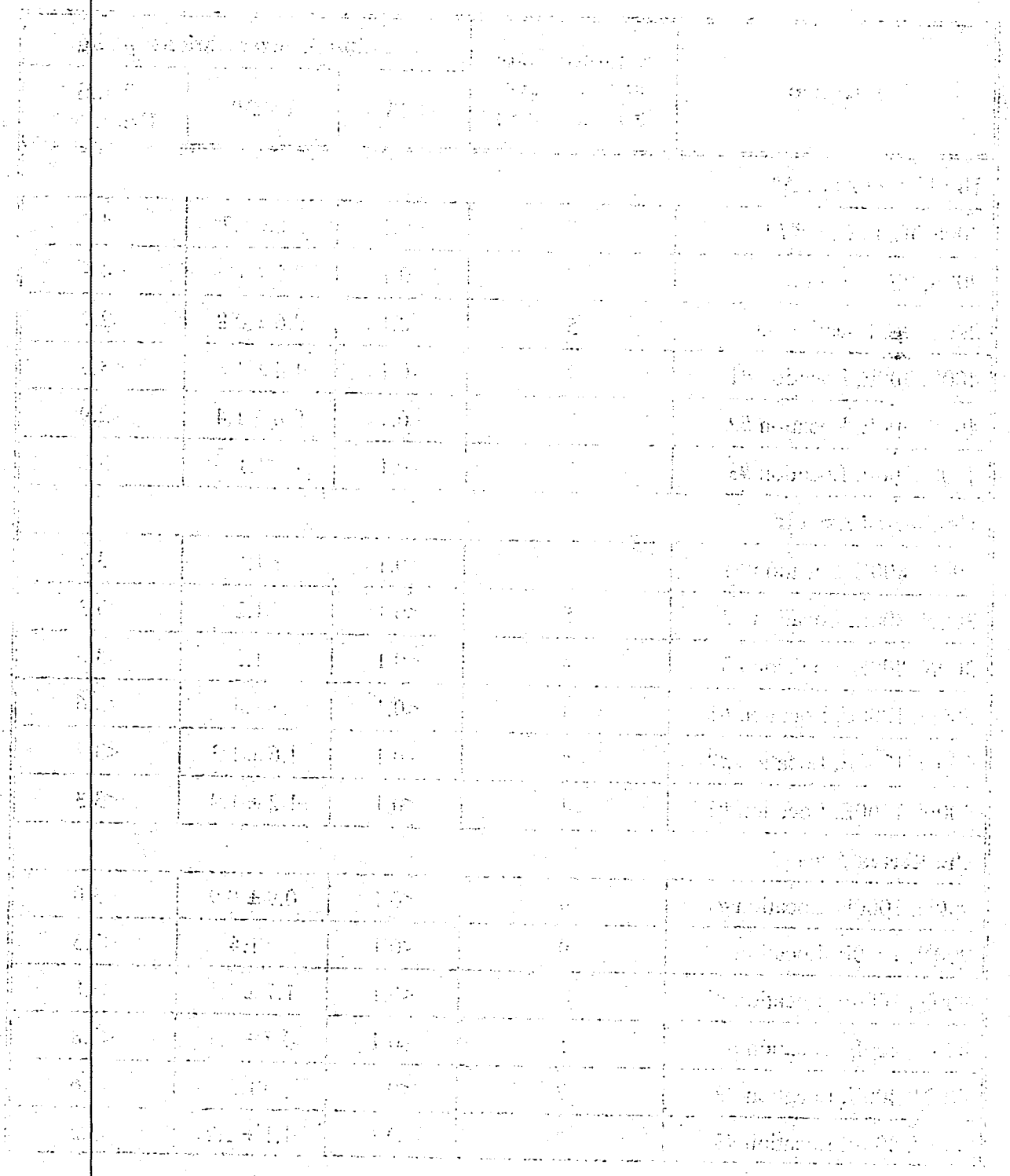
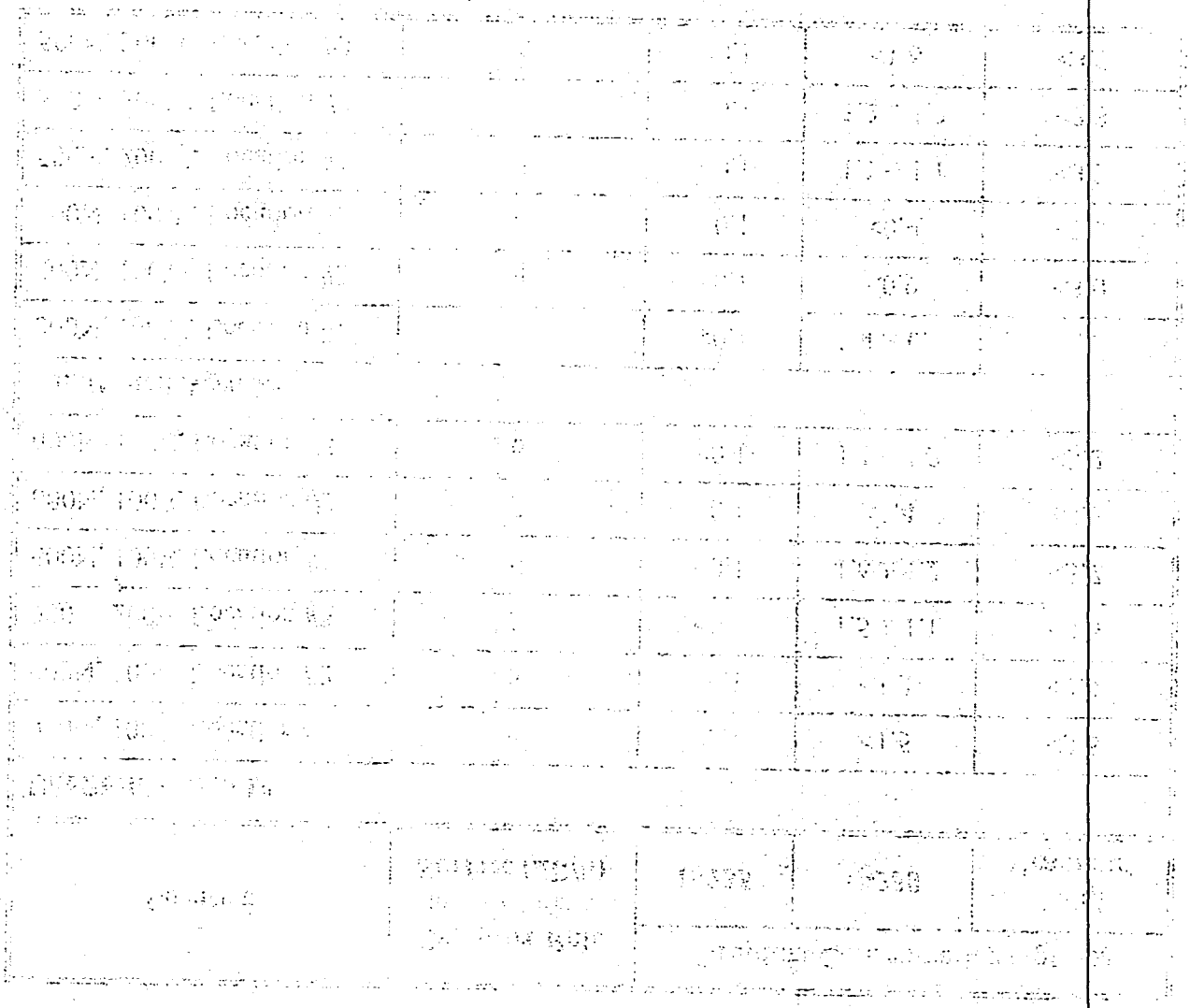


TABLE 1 (Continued)

EXPOSURE RATES AND
URANIUM CONCENTRATIONS IN SOIL SAMPLES
FROM PHASE I UNAFFECTED AREAS
KERR-McGEE CORPORATION, CIMARRON FACILITY
CRESCENT, OKLAHOMA

Location	Exposure Rate at 1 m Above Surface (μR/h)	Uranium Concentrations (pCi/g)		
		U-235	U-238	Total Uranium[a]
Unaffected Area D[f]				
900N, 200E, Location #1	6	<0.1	<1.5	<3.6
900N, 200E, Location #2	5	<0.1	<1.3	<3.4
900N, 200E, Location #3	5	<0.1	1.5 ± 1.1	<3.6
600N, 100E, Location #1	6	<0.1	1.6 ± 1.2	<3.7
600N, 100E, Location #2	5	<0.1	<1.4	<3.5
600N, 100E, Location #3	6	<0.1	1.1 ± 1.2	<3.2
Unaffected Area E[g]				
800N, 100W, Location #1	6	<0.1	0.4 ± 0.7	<2.5
800N, 100W, Location #2	4	<0.1	<0.9	<3.0
800N, 100W, Location #3	4	<0.1	<0.9	<3.0
500N, 200W, Location #1	6	<0.1	1.1 ± 1.1	<3.2
500N, 200W, Location #2	7	<0.1	1.2 ± 1.2	<3.3
500N, 200W, Location #3	6	<0.1	<1.6	<3.7

[a]Total uranium was calculated by the sum of U-238, U-235, and U-234, using an U-234:U-235 activity ratio of 20, based on alpha spectrometry results (from reference ORISE 1995b). The U-235 concentration was used to estimate the U-234 concentration because the ratio of U-234:U-235 is fairly consistent at both background concentrations and at positive levels of enriched uranium.
[b]Refer to Figures 3 and 4.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]Refer to Figures 5 and 6.
[e]Refer to Figures 7 and 8.
[f]Refer to Figures 9 and 10.
[g]Refer to Figures 11 and 12.



REFERENCES

Cimarron Corporation (Cimarron 1995). Final Status Survey Report Phase I Areas at the Cimarron Facility. Cimarron Corporation, Oklahoma City, OK; July 1995.

Oak Ridge Institute for Science and Education (ORISE 1995a). Confirmatory Survey Plan for the Phase I Unaffected Areas at the Cimarron Facility, Cimarron Corporation, Crescent, Oklahoma (Docket File No. 70-0925). Oak Ridge, TN; October 1995.

Oak Ridge Institute for Science and Education (ORISE 1995b). Draft Report - Confirmatory Survey for the South Uranium Yard Remediation, Kerr-McGee Corporation, Cimarron Facility, Crescent, Oklahoma. Oak Ridge, TN; June 1995.

U.S. Nuclear Regulatory Commission (USNRC 1981). Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations. Washington, D.C.: Federal Register 46 (205): 52061-52063; October 1981.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

DIRECT RADIATION MEASUREMENT

Instruments

Bicron Micro-Rem Meter
(Bicron Corporation, Newbury, OH)

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Detectors

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

Laboratory Analytical Instrumentation

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans for gamma activity were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. The detector and instrument combination used for scans was:

Gamma - NaI scintillation detector with ratemeter.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a microrem meter. The microrem meter was positioned one meter above the surface and allowed to stabilize. Although the microrem meter displays data in μrem/h, the μrem/h to μR/h conversion factor is essentially unity.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Surface soil samples were collected at a depth of 0-15 cm. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gamma Spectrometry

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system.

Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

U-235 0.186 MeV
U-238 0.063 MeV from Th-234*

*Secular equilibrium assumed.
Spectra were also reviewed for other identifiable photopeaks.

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data based only on counting statistics. Additional uncertainties associated with sampling and measurement procedures have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable concentration (MDC), were based on 2.71 plus 4.65 times the standard deviation of the background count. When the activity was determined to be less than the MDC of the measurement procedure, the result was reported as less than MDC. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

Calibration and Quality Assurance

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used.

Analytical and field survey activities were conducted in accordance with procedures from the following ESSAP documents:

- Survey Procedures Manual, Revision 9 (April, 1995)
- Laboratory Procedures Manual, Revision 9 (January, 1995)
- Quality Assurance Manual, Revision 7 (January, 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

APPENDIX C

GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document established guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	--	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	--	1,000
Insoluble	35	300	--	3,000
Enriched Uranium:				
Soluble	30	100	--	1,000
Insoluble	30	250	--	2,500

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.