1 of 1

AN AERIAL RADIOLOGICAL SURVEY OF THE AMES LABORATORY AND SURROUNDING AREA

AMES, IOWA

DATE OF SURVEY: JULY 1991

R. J. Maurer
Project Scientist

REVIEWED BY

H. W. Clark, Jr., Manager
Nuclear Radiation Department

This Document is UNCLASSIFIED

C. K. Mitchell
Classification Officer

This work was performed by EG&G/EM for the United States Department of Energy under Contract Number DE-AC08-93NV11265.

ABSTRACT

An aerial radiological survey of the Ames Laboratory and surrounding area in Ames, Iowa, was conducted during the period July 15-25, 1991. The purpose of the survey was to measure and document the terrestrial radiological environment at the Ames Laboratory and the surrounding area for use in effective environmental management and emergency response planning. The aerial survey was flown at an altitude of 200 feet (61 meters) along a series of parallel lines 350 feet (107 meters) apart. The survey encompassed an area of 36 square miles (93 square kilometers) and included the city of Ames, Iowa, and the Iowa State University.

The results are reported as exposure rates at 1 meter above ground level (inferred from the aerial data) in the form of a gamma radiation contour map. Typical background exposure rates were found to vary from 7 to 9 microroentgens per hour ($\mu\text{R/h}$). No anomalous radiation levels were detected at the Ames Laboratory. However, one anomalous radiation source was detected at an industrial storage yard in the city of Ames.

In support of the aerial survey, ground-based exposure rate and soil sample measurements were obtained at several sites within the survey perimeter. The results of the aerial and ground-based measurements were found to agree within the expected uncertainty of $\pm 15\%$.

CONTENTS

Abstract	ii
----------------	----

Sections

1.0 Introduction	1
2.0 Survey Site Description	1
3.0 Natural Background Radiation	1
4.0 Survey Equipment and Procedures	3
4.1 Aerial Measuring System	3
4.2 Mobile Data Processing Laboratory	3
4.3 Ground-Based Measurements	4
4.4 Survey Procedures	4
5.0 Data Reduction Procedures	4
5.1 Gross Count Rate Method	5
5.2 Man-Made Gross Count Rate Method	5
6.0 Results	6
6.1 Terrestrial Exposure Rate Contour Map	6
6.2 Man-Made Gross Count Rate Contour Map	6
6.3 Gamma Spectral Analysis	6
6.4 Ground-Based Measurements	7
7.0 Comparison of 1977 and 1991 Aerial Surveys	7
8.0 Summary	7

Figures

1 Terrestrial Gamma Exposure Rate Contour Map	2
2 MBB BO-105 Helicopter with Detector Pods	3
3 Mobile Computer Processing Laboratory	4
4 Background Gamma Spectrum	6
5 Net Gamma Spectrum over ROI	7

Table

1	Exposure Rates from Aerial and Ground-Based Measurements	8
---	--	---

Appendix

A	Survey Parameters	9
	References	10

1.0 INTRODUCTION

The United States Department of Energy (DOE) maintains an aerial radiological surveillance capability called the Aerial Measuring System (AMS).¹ The AMS is based at DOE's Remote Sensing Laboratories located at Nellis Air Force Base in Las Vegas, Nevada, and Andrews Air Force Base in Washington, D.C. Since its inception in 1958 by the Atomic Energy Commission (predecessor to the DOE), the AMS has been used in a nationwide program to map the terrestrial gamma radiation environment in and around facilities producing, utilizing, or storing radioactive materials. The AMS is presently operated and maintained by EG&G Energy Measurements Inc., (EG&G/EM), under contract to the DOE. The aerial surveys provide data for assisting in effective environmental management at nuclear facilities in addition to generating radiological background templates for repeat surveys in the event of a large-scale radioactive release. EG&G/EM routinely conducts aerial surveys for the DOE, the Nuclear Regulatory Commission, and other government agencies as part of an ongoing nationwide program to map and document the radiological baseline conditions at various nuclear sites. Aerial radiological surveys have been effective in detecting regions of enhanced radiation, determining average ground level exposure rates, and identifying specific radionuclides associated with regions of anomalous radiation levels.

An aerial radiological survey of the Ames Laboratory was last conducted in 1977 by EG&G/EM using a helicopter flying at an altitude of 150 feet (46 meters) above ground level (AGL) and a speed of 70 knots (36 meters/second).² The present aerial survey was requested by the DOE to determine the extent of the radiological impact of laboratory operations on the surrounding environment over the last fourteen years. Nuclear research at the Ames Laboratory has not been conducted since the research reactor was decommissioned in 1981. Several other decontamination projects at storage sites in the area were conducted in the early 1980s and are now complete. The present survey served as a final verification of the decontamination and decommissioning of the research reactor and storage sites.

The survey encompassed an area of 36 square miles (93 square kilometers) which included the Ames Laboratory, the Iowa State University campus, and the city of Ames. Radiation data are shown as isopleths

superimposed on a recent aerial photograph (March 1991) of the Ames Laboratory, giving the gamma exposure rates at 1 meter above ground level attributed to natural and man-made radionuclides.

In support of the aerial measurements, ground-based exposure rates and soil samples were obtained from four "benchmark" sites located within the survey boundary. Radionuclide assay of the soil samples was performed to determine radioisotopic concentrations and exposure rates. Oblique aerial photographs of the Ames Laboratory facilities were also obtained in conjunction with the survey.

2.0 SURVEY SITE DESCRIPTION

The Ames Laboratory is operated for the DOE by the Iowa State University System. The laboratory facilities are located on the Iowa State University campus in Ames, Iowa. The survey boundary is designated on Figure 1 and includes the city of Ames and the Iowa State University campus. The surrounding area consists mainly of flatlands ranging from 800 to 1,000 feet (244 to 305 meters) above sea level.

The Ames Laboratory was established in the 1940s following the development of an efficient process to purify uranium for atomic energy. The laboratory continued processing uranium until 1945. In 1947, the Ames Laboratory was designated as a research facility for the U.S. Atomic Energy Commission.

3.0 NATURAL BACKGROUND RADIATION

Natural background gamma radiation originates from radioactive nuclides which are present in minute concentrations in the earth and atmosphere as well as cosmic rays emanating from outer space. Terrestrial radiation, which originates primarily from the nuclides in either the uranium decay chain, the thorium decay chain, or radioactive potassium, is detected at the surface of the earth and has exposure rates between 1 and 15 $\mu\text{R/h}$ (9 and 130 mrem/yr). The exposure rates from terrestrial radionuclides are dependent on the composition of the soil and bedrock near the point of interest. In addition to the above-mentioned sources of natural radiation, cesium-137 (^{137}Cs), a radioactive by-product of nuclear fission, is present worldwide in trace quantities from fallout due to above-ground nuclear weapons tests conducted until

CONVERSION SCALE

LEGEND

LOCATION DIAGRAM

FEET
METERS

1:10,000

the early 1960s. Exposure rates due to ^{137}Cs in the environment are typically less than $1\ \mu\text{R}/\text{h}$.³

Radon gas, a by-product in the decay chain of both uranium and thorium, diffuses through the soil into the atmosphere and contributes to the radiation levels near the surface of the earth. The radon concentration in a particular area, however, depends on several factors including meteorological conditions, mineral compositions, and soil permeability. Airborne radiation from radon and its decay products typically contributes from 1 to 10 percent to the natural radiation background.

Cosmic rays, high-energy radiation originating from outer space, also contribute to the natural radiation background. The cosmic rays from outer space shower the earth with a nearly constant flux of radiation which interacts with atoms in the earth's atmosphere and soil producing an additional source of background activity. Radiation levels due to cosmic rays vary with altitude and geomagnetic latitude. Typical values range from $3.3\ \mu\text{R}/\text{h}$ at sea level to $12\ \mu\text{R}/\text{h}$ (up to $100\ \text{mrem}/\text{yr}$) at elevations of 10,000 feet (3 kilometers).⁴ For the Ames area, the cosmic ray contribution is about $3.8\ \mu\text{R}/\text{h}$.

4.0 SURVEY EQUIPMENT AND PROCEDURES

4.1 Aerial Measuring System

The survey was conducted using the Messerschmitt-Bolkow-Blohm (MBB) BO-105 helicopter shown in Figure 2. The helicopter was outfitted with two large detector pods and a Radiation and Environmental Data Acquisition and Recorder System, Version IV (REDAR IV). The two large detector pods were mounted on the sides of the skid rack of the helicopter. Each pod contained four rectangular $2\text{-in} \times 4\text{-in} \times 16\text{-in}$ sodium iodide, $\text{NaI}(\text{Tl})$, gamma ray detectors. The energy response of the detector array was characterized using the 60 keV and 1,274 keV lines from americium-241 (^{241}Am) and sodium-22 (^{22}Na) sources, respectively. At a survey altitude of 200 feet (61 meters), the large detector array electronics will exhibit degradation for large area, ground-level exposure rates exceeding $55\ \mu\text{R}/\text{h}$. A single detector log is used to extend the dynamic range of the aerial measuring system to about $440\ \mu\text{R}/\text{h}$.

FIGURE 2. MBB BO-105 HELICOPTER WITH DETECTOR PODS

Data acquisition was performed using the REDAR IV system, a compact microprocessor computer system designed for use in aircraft. The REDAR IV recorded the data from the detector system, aircraft positioning system, and environmental variables, such as ambient temperature and barometric pressure, and stored it on magnetic tape. The REDAR IV is also equipped with a multichannel analyzer and video display capability for inflight monitoring of the gamma-energy spectrum, as well as the other flight parameters.

The aircraft positioning was established using an ultrahigh-frequency ranging system and a radar altimeter. Two ground-based transponders, one located on the County Courthouse building in Nevada, Iowa, and one located on the City Hall building in Story City, Iowa, were periodically interrogated by a master unit in the helicopter. By the method of triangulation, the precise position (± 10 feet) of the helicopter was constantly monitored. The position information was recorded on magnetic tape and also fed into a steering indicator to direct the pilot along a predetermined set of flight lines.

4.2 Mobile Data Processing Laboratory

The operations base for the survey was the Ames Airport in Ames, Iowa. The Radiation and Environmental Data Analyzer and Computer (REDAC) system, a mobile computer laboratory for analysis of the aerial survey data (Figure 3), was located at the operations base. The REDAC system hosts a wide range of computer hardware which includes a Data General MV-7800XP computer with 4 megabytes of memory, 1.1 gigabytes of disk space for mass storage, two 9-track tape drives for data transfer and

FIGURE 3. MOBILE COMPUTER PROCESSING LABORATORY

archiving, a 36-inch wide plotter for data contouring, and three video graphics displays for data viewing. The REDAC system also houses an extensive library of software which was used to provide on-site preliminary analysis of the aerial data on a flight-by-flight basis as well as to monitor pre- and post-flight quality assurance checks for the AMS.

4.3 Ground-Based Measurements

Total exposure rates and soil samples obtained from four ground-based benchmark sites served to verify the aerial measurements. The four sites, labeled 1 through 4 in Figure 1, were identified during the aerial survey as having only natural background radioactivity. At each site, total exposure rates were measured with a pressurized ionization chamber and five soil samples were taken for laboratory analysis. Radionuclide assay of the soil samples was performed at the EG&G/EM Santa Barbara Operations Office in accordance with established procedures.⁵

4.4 Survey Procedures

The aerial radiological survey of the Ames Laboratory and surrounding area was conducted according to

EG&G/EM standardized procedures which will be discussed only briefly in this section.^{1,6}

Two series of measurements were conducted to determine the attenuation of gamma radiation in air as a function of altitude for use in the data analysis. These measurements consisted of altitude profiles flown over a large body of water and a designated land test line. Each altitude profile consisted of a series of one-minute measurements over the water and test lines at precise altitudes ranging from 150 feet (46 meters) to 800 feet (244 meters). The Saylorville Lake was chosen for the water measurements. Data collected during the altitude profile over water were used to determine the nonterrestrial radiation (*i.e.*, radiation caused by airborne radon, the helicopter and detector system, and cosmic rays).

For the land test line, an open field en route from the operations base to the survey area was chosen. The terrestrial radiation measured over the land test line, corrected for the nonterrestrial radiation measured over water, was used to derive the air attenuation coefficient for the gamma radiation. In addition, the land test line was flown at survey altitude at the beginning and end of each flight to monitor fluctuations in the radon concentrations and to verify the proper operation of the detection system.

The aerial survey covered an area of 36 square miles (93 square kilometers) as outlined by the survey boundary in Figure 1. The flight pattern consisted of 91 parallel flight lines separated by 350-foot (107-meter) intervals. The survey was flown at an altitude of 200 feet (61 meters) above ground level and an average ground speed of 70 knots (36 meters/second).

5.0 DATA REDUCTION PROCEDURES

Two methods were used to analyze the aerial radiation data. The first was the gross count rate method which was used to determine ground level exposure rates. The second was the spectral window method which was used to determine the location of man-made radionuclides.

5.1 Gross Count Rate Method

The gross count rate is defined as the integrated count rate in the 38 to 3,026 keV energy window of a gamma energy spectrum. For natural background, the gross count rate consists primarily of gammas from potassium-40 (^{40}K), uranium-238 (^{238}U), thorium-232 (^{232}Th), and their decay products: bismuth-214 (^{214}Bi) from ^{238}U , thallium-208 (^{208}Tl) and actinium-228 (^{228}Ac) from ^{232}Th . The algorithm used to convert the gross count rate in counts per second (cps) measured at survey altitude to terrestrial exposure rate (ER) in $\mu\text{R/h}$ at 1 meter is

$$\text{ER } (\mu\text{R/h}) = \frac{GC - BG}{902} e^{(RA - 200)C} \quad (1)$$

where

- GC = gross count rate at survey altitude
- BG = background count rate at survey altitude
- RA = radar altimeter measured altitude
- C = air attenuation factor

The background count rate is comprised of gammas from cosmic rays, the aircraft system, and airborne radon. The air attenuation factor, C , deduced empirically from the altitude spiral data, was 0.0016/foot. The conversion factor (902 cps/ $\mu\text{R/h}$) for 200 feet (61 meters) AGL was obtained from the documented EG&G/EM calibration range near Washington, D.C.⁷ The applicability of the conversion factor assumes a uniformly distributed radiation source covering an area which is large compared to the field of view of the detector system.

5.2 Man-Made Gross Count Rate Method

The aerial data were also used to determine the location of man-made radionuclides. The man-made gross count (MMGC) is defined as the fraction of the gross counts which is directly attributed to gammas from man-made radionuclides. In general, evidence for the existence of man-made radionuclides can be

found from increases in the gross count rate. However, slight increases in the gross count rate are not considered adequate reason to suspect the presence of a man-made radionuclide. Moreover, slight variations in the gross count rate may be attributed to fluctuations in the geology or changes in the ground cover.

A more conclusive approach to detecting man-made radionuclides involves a comparison of the gross count rates from various spectral windows of the gamma energy spectrum. In particular, the ratio of the integrated count rates from different spectral windows of the gamma energy spectrum will remain nearly constant when only background radiation is present. Although this procedure can be applied to any region of the gamma spectrum, the most common practice is to place into the source window all counts below 1,394 keV (*i.e.*, the region of the gamma energy spectrum where most long-lived, man-made radionuclides emit radiation), and to place into the background window all counts above 1,394 keV (*i.e.*, the region of the gamma energy spectrum which contains gamma radiation from primarily naturally-occurring radionuclides). The MMGC rate method is sensitive to low levels of man-made radiation (*i.e.*, $< 1 \mu\text{R/h}$) which occur in the presence of slight variations in the natural background.

The MMGC rate can be expressed analytically in terms of the integrated count rates in specific spectral energy windows (in keV) from the gamma energy spectrum

$$\text{MMGC} = \sum_{E=38 \text{ keV}}^{1394 \text{ keV}} \text{Counts}_E - K_B \cdot \sum_{E=1394 \text{ keV}}^{3026 \text{ keV}} \text{Counts}_E \quad (2)$$

where

$$\sum_{E=38 \text{ keV}}^{1394 \text{ keV}} \text{Counts}_E = \text{integral count rate in the energy window 38 to 1,394 keV}$$

$$\sum_{E=1394 \text{ keV}}^{3026 \text{ keV}} \text{Counts}_E = \text{integral count rate in the energy window 1,394 to 3,026 keV}$$

The constant, K_B , was obtained from background gamma ray energy spectra acquired over a region of the survey area which was identified to contain only radiation from naturally-occurring radionuclides:

$$K_B = \frac{\sum_{E=38 \text{ keV}}^{1394 \text{ keV}} \text{Counts}_E}{\sum_{E=1394 \text{ keV}}^{3026 \text{ keV}} \text{Counts}_E} \quad (3)$$

The resultant MMGC rate obtained from the above algorithm will yield an average value equal to zero for areas containing natural radionuclides and a value greater than zero for areas containing man-made radionuclides.

Since the MMGC algorithm is quite general and will respond to a wide range of radionuclides, the primary function of the MMGC is to locate man-made radioactivity. Once a region of man-made radioactivity has been identified, a detailed analysis of the gamma energy spectrum is conducted to ascertain the radionuclides present.

6.0 RESULTS

6.1 Terrestrial Exposure Rate Contour Map

The terrestrial exposure rates deduced from over 28,000 measurements were integrated with their corresponding aircraft position coordinates and compiled to produce a three-dimensional contour map. The exposure rate contour map, superimposed on an aerial photograph of the Ames area, is presented in Figure 1. The contour map shows the exposure rates ($\mu\text{R/h}$) for 1 meter AGL inferred from the aerial data. The typical background exposure rates were found to vary from 7 to 9 $\mu\text{R/h}$. Included in the radiation data is a cosmic ray exposure rate of 3.8 $\mu\text{R/h}$. The exposure rates are attributed to natural radionuclides in the soil, man-made radiation sources, and cosmic rays.

6.2 Man-Made Gross Count Rate Contour Map

The man-made gross count algorithm showed evidence for anomalous radiation levels at only one site within the survey boundary. This site, designated as "ROI" in Figure 1, was a storage yard for automobile parts located on Freel Drive in the city of Ames. The site, however, was not associated with the Ames Laboratory operations. The results of the spectral analysis from the storage yard will be discussed in Section 6.3.

6.3 Gamma Spectral Analysis

Presented in Figure 4 is a typical background gamma ray spectrum from the survey area. The dominant gamma ray activity is attributed to ^{238}U , ^{232}Th , their decay products (^{214}Bi from ^{238}U , ^{208}Tl and ^{228}Ac from ^{232}Th), and ^{40}K .

As indicated in Section 6.2, anomalous radiation levels were detected at only one site within the survey boundary. This site, designated as "ROI" in Figure 1, was identified to be a storage yard for automobile parts located in the city of Ames. Further investigation revealed that the anomalous activity originated from an area of approximately 100 feet by 100 feet in size.⁸ Soil samples obtained from the site were found to contain decay products from natural uranium and thorium. A net gamma spectrum obtained over the "ROI"

FIGURE 4. BACKGROUND GAMMA SPECTRUM

is presented in Figure 5. The spectrum shows gamma rays characteristic of the decay products from uranium and thorium in excess of natural background.

6.4 Ground-Based Measurements

In situ gamma ray ionization chamber and soil sample measurements were obtained from four benchmark sites (identified in Figure 1) within the survey boundary to support the integrity of the aerial survey. The exposure rates at one meter AGL inferred from the aerial data and the ground-based measurements are listed in Table 1.⁹ The exposure rates inferred from

FIGURE 5. NET GAMMA SPECTRUM OVER ROI

the aerial survey were found to agree with the ground-based measurements within the expected uncertainty of $\pm 15\%$.

7.0 COMPARISON OF 1977 AND 1991 AERIAL SURVEYS

In the present survey, no anomalous radiation areas were detected within the confines of the Ames Laboratory or the Iowa State University campus. The prominent radiation areas detected in the 1977 survey were at the laboratory research reactor and a city waste treatment facility. The two sites show no evidence for anomalous radiation levels in the present survey.

The present survey revealed only one area which was found to exhibit anomalous radiation levels. The site is a storage yard for automobile parts located on Freel Drive in the city of Ames.

8.0 SUMMARY

A radiological survey of the Ames Laboratory and surrounding area was conducted during the period July 15-25, 1991. The aerial survey was conducted at 200 feet (61 meters) AGL over a 36-square-mile (92-square-kilometer) area. The terrestrial exposure rates at 1 meter AGL were generally found to vary from 7 to 9 $\mu\text{R/h}$. No significant man-made gamma activity was detected at the Ames Laboratory or in the city of Ames with the exception of an industrial storage yard.

Table 1. Exposure Rates from Aerial and Ground-Based Measurements			
	One Meter Gamma Exposure Rates ($\mu\text{R/h}$)		
Site No.	Aerial Survey	Ion Chamber ¹	Soil Analysis ²
1	9.1 ± 1.4	8.7 ± 0.5	9.1 ± 0.6
2	8.6 ± 1.3	8.9 ± 0.5	9.1 ± 0.8
3	8.7 ± 1.3	9.3 ± 0.5	9.6 ± 1.2
4	8.5 ± 1.3	9.5 ± 0.5	9.5 ± 1.1

¹ Reuter-Stokes Model #RSS-112, Serial #G003 and R-3588.

² Estimate includes a cosmic ray contribution of $3.8 \mu\text{R/h}$, and a moisture correction of the form $1/(1+m)$.

APPENDIX A

SURVEY PARAMETERS

Survey Site:	Ames Laboratory Ames, Iowa
Survey Coverage:	36 mi ² (93 km ²)
Survey Date:	July 15-25, 1991
Survey Altitude:	200 ft (61 m)
Aircraft Speed:	70 knots (36 m/s)
Line Spacing:	350 ft (107 m)
Line Direction:	North-South
Detector Arrays:	Eight 2-in × 4-in × 16-in NaI(Tl) detectors
Acquisition System:	REDAR IV
Conversion Factor:	902 cps/μR/h
Air Attenuation Coefficient:	0.0016/ft
Aircraft:	MBB BO-105 helicopter
Survey Crew:	R. Maurer, L. Ruff, M. Lukens, D. Van Order, R. Rea, C. Ward

REFERENCES

1. Jobst, J.E. "The Aerial Measuring System Program." *Nuclear Safety*, 1979, 20:136-147.
2. Feimster, E.L. *An Aerial Radiological Survey of U.S. Department of Energy Sites in Ames, Iowa*, Report No. EGG-1183-1686. EG&G/EM, Las Vegas, Nevada, 1977.
3. Mohr, R.A. and L.A. Franks. *Compilation of Cs-137 Concentrations at Selected Sites in the Continental United States*, Report No. EGG-1183-2437, S-724-R. EG&G/EM, Santa Barbara, California, 1982.
4. Klement, A.W., C.R. Miller, R.P. Min, and B. Shleren. *Estimate of the Ionizing Radiation Doses in the United States 1960-2000*, U.S. EPA Report ORP/CD72-1. Environmental Protection Agency, Washington, D.C., 1972.
5. Mohr, R.A., A.E. Fritzsche, and L.A. Franks. *Ground Survey Procedures*, Report No. EGG-1183-2339, S635-R. EG&G/EM, Santa Barbara, California, 1976.
6. Boyns, P.K. *The Aerial Radiological Measuring System (ARMS): Systems, Procedures and Sensitivity*, Report No. EGG-1183-1691. EG&G/EM, Las Vegas, Nevada, 1976.
7. Mohr, R.A. *Ground Truth Measurements at the Calvert County, Maryland Test Line*, Report No. EGG-10282-2066. EG&G/EM, Santa Barbara, California, 1985.
8. Fobair, R. Private Communication. Bureau of Radiological Health, Iowa Department of Public Health, Ames, Iowa, May 1992.
9. Mohr, R.A. Private Communication. EG&G/EM, Santa Barbara, California, September 1991.

DISTRIBUTION

DOE/CH

J. Fletcher (1)

AMES LABORATORY

W. P. Waters (7)

DOE/DP

J. E. Rudolph (3)

EG&G/EM

H.W. Clark	LVAO	(1)
J. F. Doyle	LVAO	(1)
E. L. Feimster	LVAO	(1)
L. A. Franks	SBO	(1)
P. P. Guss	WAMD	(1)
T. J. Hendricks	LVAO	(1)
R. J. Maurer	WAMD	(1)
C. K. Mitchell	LVAO	(1)
R. A. Mohr	SBO	(1)
G. R. Shipman	WAMD	(1)
W. J. Tipton	LVAO	(1)
P. H. Zavattaro	LVAO	(1)

DOE/HQ

OSTI (25)

DOE/NSIC

R. S. Scott (3)

DOE/NV

C. A. Cox	(1)
M. R. Dockter	(1)
S. C. Ronshaugen	(2)

LIBRARIES

RSL	(30)
SBO	(1)
TIC	(1)

AN AERIAL RADIOLOGICAL SURVEY OF THE
AMES LABORATORY
AND SURROUNDING AREA
AMES, IOWA
EGG-10617-1242
DATE OF SURVEY: JULY 1991
DATE OF REPORT: APRIL 1993

**DATE
FILMED**

10 / 14 / 93

END