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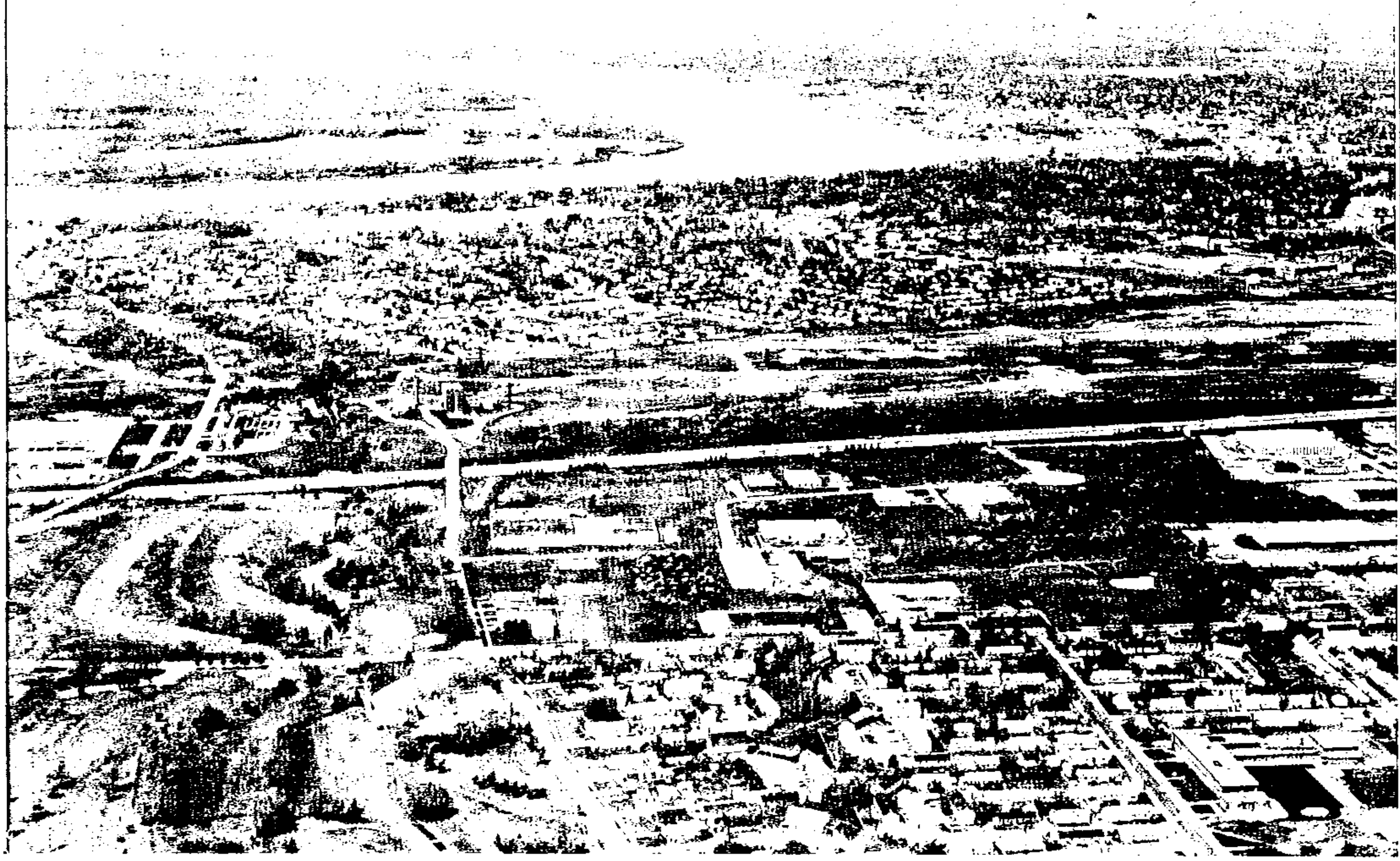

AN AERIAL RADIOLOGICAL SURVEY FOR ^{241}Am CONTAMINATION IN

TONAWANDA, NEW YORK

DATE OF SURVEY: MAY 1984

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ABSTRACT

An aerial survey for ^{241}Am contamination was conducted over a portion of Tonawanda, New York during the period 18 through 25 May 1984. The survey was conducted in three phases: (1) hovers, (2) a high altitude total gamma survey, and (3) a low altitude survey for ^{241}Am. No radiation anomalies associated with ^{241}Am were observed in the high altitude survey phase. However, two areas of ^{241}Am contamination were identified by the low altitude survey phase. Results of both aerial survey phases are presented on aerial photographs of the area.

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1.0 INTRODUCTION

An aerial radiological survey for radioactive ^{241}Am contamination was conducted over a portion of Tonawanda, New York during the period 18 through 25 May 1984. The survey was performed by the United States Department of Energy (DOE) at the request of the State of New York, Department of Health, in support of that state's response to the ^{241}Am contamination problem discovered in Tonawanda. The aerial survey utilized the DOE's Aerial Measuring System, which is operated by EG&G Energy Measurements, Inc. (EG&G/EM), Las Vegas, Nevada.[1] Customarily, this system is used for environmental monitoring and research at sites which handle radioactive materials of interest to the Department of Energy, Nuclear Regulatory Commission, or Environmental Protection Agency.

The purpose of the aerial survey was to help state radiological health officials locate areas contaminated with ^{241}Am. State officials had located isolated areas of contamination by careful investigation prior to the survey. The aerial operations were conducted to broadly expand the scope of the state's investigation so that no seriously contaminated area in Tonawanda would go undetected.

The aerial survey was performed in three separate phases. The first phase of the operation was comprised of a series of hovers over sites of interest. The second phase was a high altitude survey for terrestrial gamma radiation in the area. The third phase was a careful low altitude survey of a portion of that area for ^{241}Am contamination.

The ^{241}Am contamination originated at EAD Metallurgical, Inc., which manufactured certain radioactive components required for ionization-type smoke detectors. The ^{241}Am contamination found its way from the EAD facility into the sewer and was concentrated in the sludge of a nearby sewage treatment plant. The sludge was then burned at one of two adjacent incinerators, which further concentrated the ^{241}Am in the ash. The ash was routinely dumped and buried at a landfill adjacent to the incinerator.

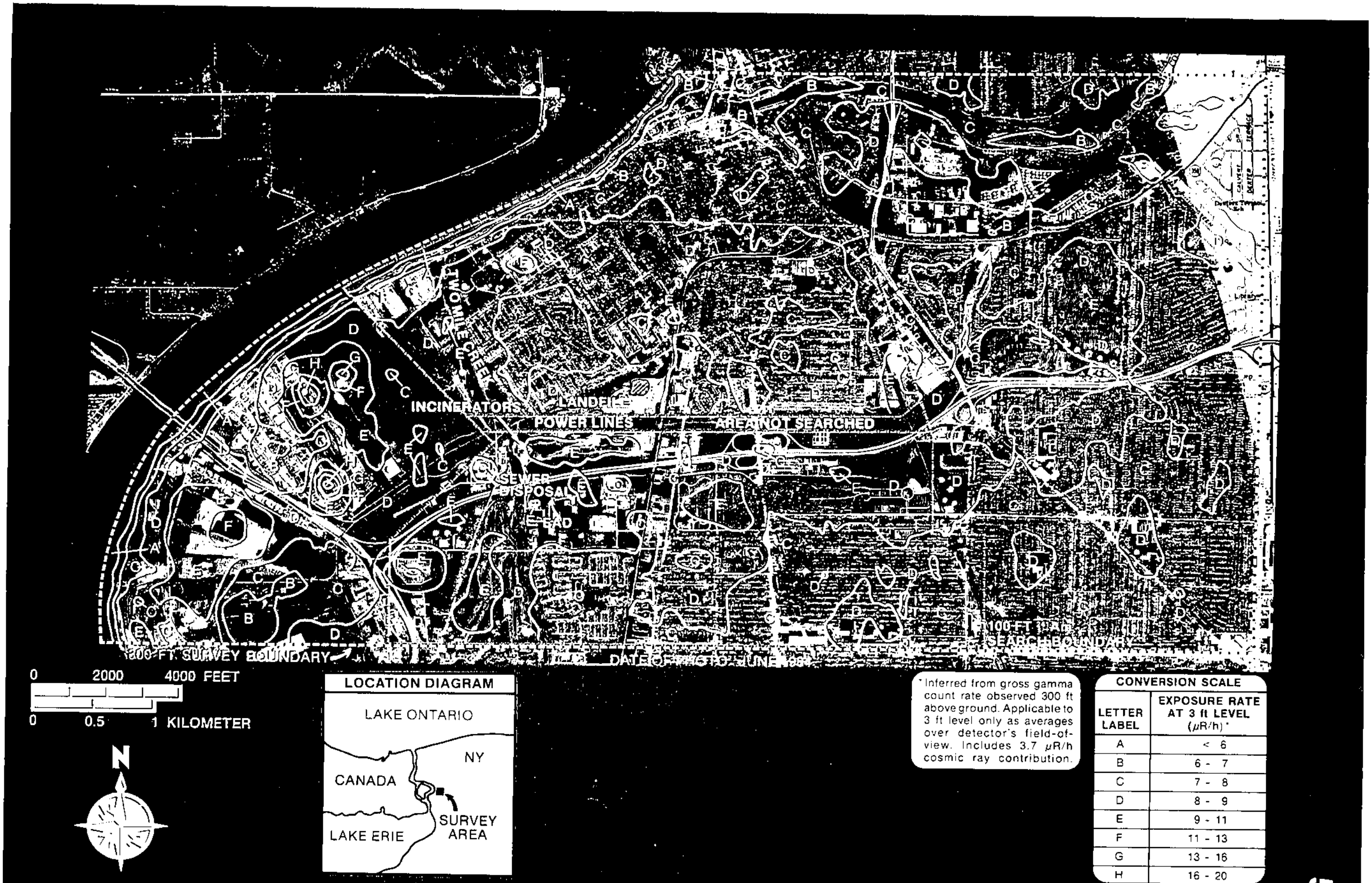
Aerial radiological detection systems are capable not only of detecting regions of enhanced radiation but also of determining the area averaged surface exposure rate, soil concentration and the specific nuclide(s) responsible for any anomaly. However, since these systems average photon flux due to gamma-emitting radionuclides over a large area (several hectares), aerial measurements—compared to ground-based measurements—may significantly underestimate the intensity of localized sources of enhanced radiation. The effect becomes increasingly more pronounced as the spatial extent of a source of radiation is made small with respect to the large area averaged by the airborne detection system. Therefore, ground measurements may also be necessary to accurately define the extent and intensity of highly localized anomalous areas.

It is customary to report survey results as radiation exposure rates in microroentgens per hour (μR/h) extrapolated to 1 meter (3 feet) above ground level. Results may also be reported in terms of soil concentration per unit volume (pCi/g) or per unit area (nCi/m^2). Both require knowledge of the radionuclide's depth distribution in the soil. If this depth distribution is unknown, estimates can be employed. However, substantial uncertainty will result, particularly in the concentration-per-unit area.

2.0 SURVEY AREA

The 16-square-mile area surveyed at high altitude in the second phase was centered on the sewage treatment plant-incinerator-landfill complex as designated in Figure 1 by a white border. The survey boundary extended approximately 2.4 kilometers (1.5 miles) to the north and south of the complex and, typically, 4 kilometers (2.5 miles) to the east and west. The area was bounded on the west and north by the Tonawanda Channel of the Niagara River. The survey area was bisected by many power lines, some as tall as 60 meters (200 feet). These lines presented no obstacle to the high altitude survey but greatly affected the low altitude survey.

The survey area examined at low altitude in the third phase, designated in Figure 1 with a blue border, encompassed only 16.6 square kilometers (6.5 square miles). Boundaries in the low altitude survey area were often dictated by navigational obstacles, such as the power lines. No search operations could be conducted in the immediate vicinity of the power lines, as illustrated in Figure 1. This survey area included all sites of interest, the local drainage basin, and a reasonable margin around these areas. There were no residences, schools, etc., in the immediate vicinity of the sites of interest, although the northernmost portion of this survey area was densely populated.



CONVERSION SCALE

LETTER LABEL	EXPOSURE RATE AT 3 ft LEVEL (μR/h)*
A	< 6
B	6 - 7
C	7 - 8
D	8 - 9
E	9 - 11
F	11 - 13
G	13 - 16
H	16 - 20

Figure 1. *AERIAL RADIOLOGICAL SURVEY AND ^{241}Am SEARCH RESULTS SUPERIMPOSED ON AN AERIAL PHOTOGRAPH OF TONAWANDA, NEW YORK. Isoradiation contours of total external gamma exposure rate present the result of the aerial survey. Areas contaminated with ^{241}Am, located in the aerial search, are identified with blue cross-hatching.*

3.0 SURVEY METHODS

A Messerschmitt-Bolkow-Blohm (MBB) BO-105 helicopter, equipped with a special radiological detection system called REDAR IV,* was used for the survey and search. The helicopter was flown at a constant altitude above ground level and a constant ground speed along a series of closely spaced parallel lines. REDAR IV acquired and recorded both radiation and positional data each second. The system also provided a navigational display, which guided the pilot on these lines. A detailed description of the equipment, procedures, and sensitivities is reported elsewhere.[2]

As previously mentioned, the aerial survey operations were comprised of three phases:

1. A series of hovers over or near sites of interest.
2. A survey of the total gamma radiation present.
3. A detailed low altitude survey for ^{241}Am.

Hovers were conducted during the first helicopter flight over the following locations: (1) the EAD Metallurgical, Inc. facility, (2) the sewage treatment plant, (3) two incinerators, (4) the landfill, and (5) two points along Two Mile Creek. These hovers, which provided optimum sensitivity to ^{241}Am, were used to establish the need for an aerial survey for ^{241}Am. Hovers were conducted at as low an altitude as safely possible, 12 meters (40 feet), for a period of about one minute, hence providing a 60-fold enhancement of sensitivity over that achieved in the survey operations. After the hovers had demonstrated that an airborne survey for ^{241}Am would be productive, the first aerial survey at high altitude was conducted.

This first aerial survey mapped out all the terrestrial radiation in the area, but it was not intended as a specific search for ^{241}Am. The entire area was surveyed by flying a pattern of parallel lines 91 meters (300 feet) above ground level, spaced 152 meters (500 feet) apart, at a ground speed of 105 kmph (75 knots). Only two short flights were required to complete this survey. The purpose of the survey was to provide information for planning the subsequent ^{241}Am survey and for analysis of that data. Data acquired during this survey were used to construct an isoradiation contour map of total exposure rate, presented in Figure 1.

* Radiation and Environmental Data Acquisition and Recorder System, Model IV.

The detailed low altitude survey for ^{241}Am contamination, the principal objective of the Tonawanda aerial survey operations, began immediately after the conclusion of the high altitude survey. A portion of the high altitude survey area was reflown at a much lower altitude and speed and with more closely spaced lines. This procedure achieved maximum sensitivity and the best spatial resolution of the ^{241}Am anomalies.

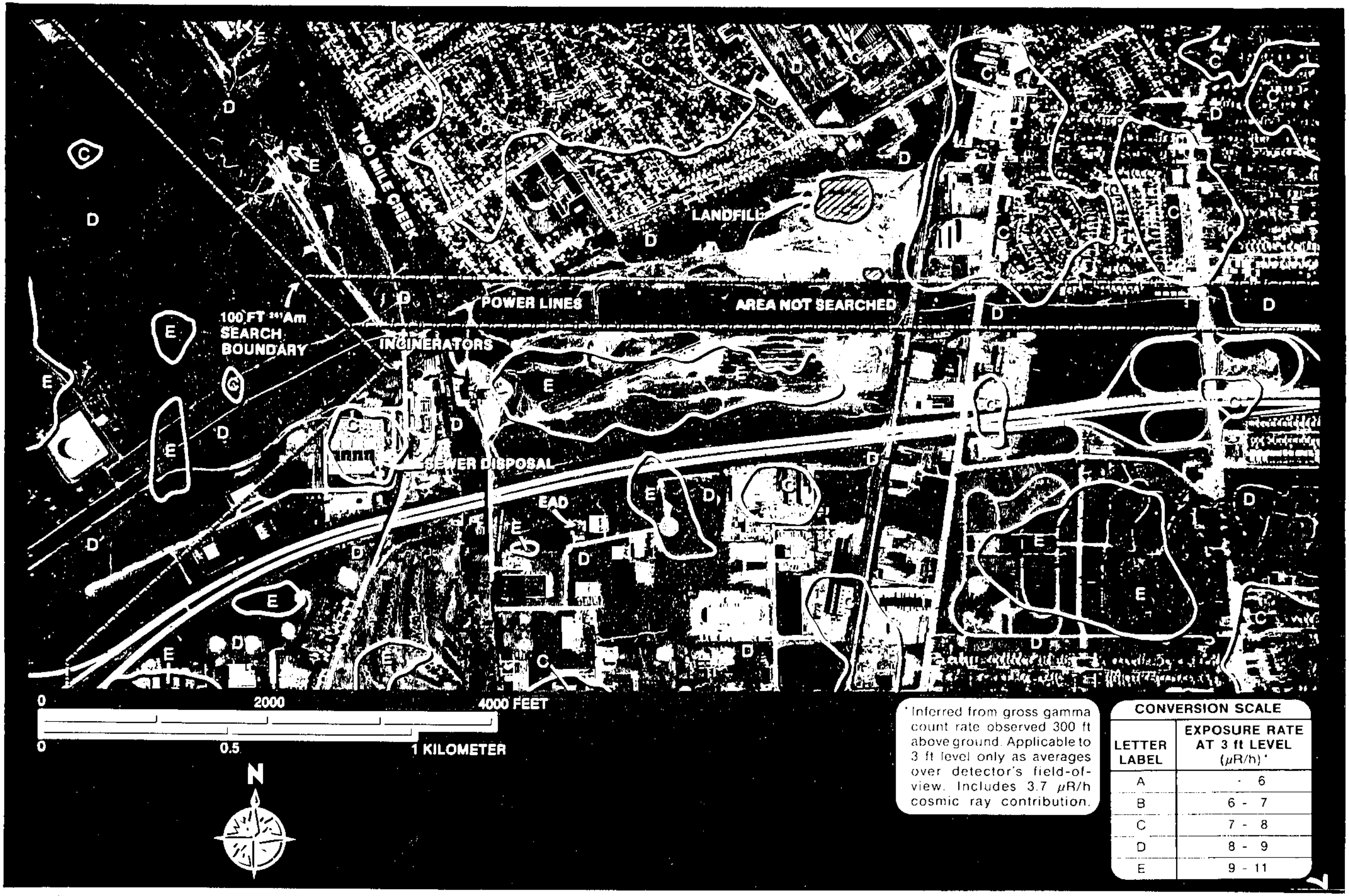
During the low altitude survey, lines spaced 52 meters (170 feet) apart were flown 30 meters (100 feet) above ground level at a ground speed of 83 kmph (60 knots). Three flights were required to complete this last phase of the operation.

Data acquired during the low altitude survey were analyzed on site by standard techniques and the results reported to the New York State Health Department officials the following day. These data were then reanalyzed by EG&G/EM in Las Vegas, Nevada using more sophisticated techniques. The results of the low altitude survey are presented in Figure 1 as cross-hatched areas denoting the presence of ^{241}Am.

4.0 RESULTS OF THE SURVEYS

The results of the high altitude aerial survey are presented in Figure 1 as total exposure rate isoradiation contours, in μR/h extrapolated to 3 feet above the ground, superimposed on an aerial photograph. These same results are also presented at an enlarged scale in Figure 2, which provides an enhanced view of just the EAD facility, the sewage treatment plant, and the landfill. Background exposure rates generally ranged between 7 and 9 μR/h. Two regions exhibiting a modestly higher exposure rate, H level at 16-20 μR/h, can be observed near the Tonawanda Channel just north of I-190. These anomalies were previously known and are due to residues from uranium processing done in the past. Exposure rates lower than 7 μR/h can be observed over bodies of water or marshy areas. No additional exposure rate due to the ^{241}Am contamination was detectable.

The results of the low altitude survey are also presented in Figures 1 and 2, as blue cross-hatched areas that denote the presence of ^{241}Am contamination. Only two areas contaminated with ^{241}Am could be detected. Both of these areas were previously known and understood to be due to contaminated ash spread in the landfill.



CONVERSION SCALE

LETTER LABEL	EXPOSURE RATE AT 3 ft LEVEL (μR/h)*
A	- 6
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Figure 2. *CLOSE-UP VIEW OF THE AERIAL RADIOLOGICAL SURVEY AND SEARCH RESULTS IN THE AREA OF PRIMARY INTEREST. Blue cross-hatching denotes ²⁴¹Am contamination.*

The average concentration in the larger area is estimated to be just in excess of 70 pCi/g. However, this value includes a substantial finite size correction (~4×). Due to the uncertainty of this correction, the concentration may actually be as low as 30 pCi/g or as high as 120 pCi/g. The smaller area requires a correction ranging between 10× to 20×. Therefore, it is difficult to assess the concentration with confidence, but it is probably near 150 pCi/g.

The minimum detectable activity (MDA) of the aerial survey system for a contaminated area greater in size than the detector's field-of-view, nearly 122 meters (400 feet) in diameter, was 18 pCi/g. However, the largest area detected during the survey was only about 30 meters (100 feet) in diameter. Therefore, as described earlier, the airborne system underestimated the actual concentration. Likewise, the actual MDA for a small area, such as that above, is correspondingly greater than for a large area. In fact, a point source of ^{241}Am must exceed 2 mCi of activity to be detected.

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2. Boyns, P.K. July 1976. *The Aerial Radiological Measuring System (ARMS): Systems, Procedures, and Sensitivity*. Report No. EGG-1183-1691. Las Vegas, NV: EG&G/EM.

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