DOE/NV/25946--684
March 2009

Radiological Survey of Downtown Washington DC for the 2009 Presidential Inauguration

Remote Sensing Laboratory
Operated by National Security Technologies, LLC
for the U.S. Department of Energy
National Nuclear Security Administration

Survey Dates: January 10 - 12, 2009

This document is UNCLASSIFIED

Reviewed by:
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March 9, 2009
Derivative Classifier

This work was done by National Security Technologies, LLC, under
Contract No. DE-AC52-06NA25946 with the U.S. Department of Energy.

DISCLAIMER

RSL Analysis of Aerial and Mobile (Ground) Radiological Data of Downtown Washington DC

Overview

At the request of the United States Secret Service, the Aerial Measuring System (AMS) conducted an aerial radiological survey on January 10 - 12, 2009. This survey covered approximately 5 square miles over downtown Washington DC.

This aerial survey was performed at the altitude of approximately 150 feet with 250 ft line spacing. Water line and test line flights were conducted to determine the non-terrestrial background contributed by aircraft, radon, and cosmic activity, and to determine the altitude-dependent air mass attenuation coefficient. The AMS twin-engine Bell 412 (tail number N412DE) helicopter based at Andrews Air Force Base was used to perform the survey.

The gamma data were collected by the AMS data acquisition system, REDAR V, using an array of twelve 2" x 4" x 16" sodium iodide (NaI) detectors mounted in two external pods on the AMS helicopter. One-second gamma-energy spectral data were recorded continuously while in flight. This spectral data allow the system to distinguish between natural terrestrial background contributions and man-made radioisotope contributions. Spectral data can also be used to identify specific man-made radioactive isotopes. Data geo-locations were determined with a Real-Time Differential Global Positioning System (RDGPS) simultaneously with radiation data.

The neutron detection system was flown along with the gamma system. The neutron system consisted of an array of eight moderated poly-ethylene matrix He-3 gas cylinder tubes. Each cylinder measured 6′ in length with a diameter of 2″. The neutron signals from the eight individual detectors were counted using the scalar inputs on the REDAR V.

A ground-based mobile mission was performed on January 12, 2009, after the aerial survey to collect data where the aircraft could not due to flight restrictions. Two mobile units were driven around the areas surrounding the United States Capitol building and the White House. Each mobile unit is equipped with four 2″ x 4″ x 16″ sodium iodide (NaI) detectors, sixteen He^3 neutron tubes (similar to the aerial system), and correlated with GPS position.

Remote Sensing Laboratory (RSL) personnel from both the Nellis and Andrews Operations provided support for this survey.

Coverage Area

The flight path for the January 10, 2009, survey is presented in Figure 1. The mobile coverage area from January 12, 2009, is presented in Figure 2.

Exposure Rate Derived from Measured Gross Counts

The estimated gamma wide-area exposure rate was derived from the total count rate measured at helicopter flight altitude. Corrections were applied to the total count rate to remove non-terrestrial background, to correct for air attenuation, and to convert the resulting net counts to a nominal ground-level exposure rate. Mathematically, the exposure rate relation may be written as:

$$E = \frac{1}{\alpha}(G - B)e^{\mu(z - z_0)}$$

Where we have:

$E[\mu R/hr] \equiv$ Estimated exposure rate at 1 meter AGL

$G[cps] \equiv$ Gross count rate measured at altitude by the survey system $(38\,KeV \rightarrow 3026\,KeV)$

$B[cps] \equiv$ Background count rate from aircraft, radon, and cosmic radiation $(38\,KeV \rightarrow 3026\,KeV)$

$z[ft] \equiv$ Instantaneous aircraft altitude in ft AGL measured by radar altimeter

$z_0[ft] \equiv$ Nominal survey altitude in ft AGL level (150)

$\mu[ft^{-1}] \equiv$ Mean air attenuation (altitude correction) coefficient (0.00185)

$\alpha\left[\frac{cps}{\mu R/hr}\right] \equiv$ Conversion Coefficient from counts at altitude to exposure rate at 1 meter (1724)

Ground-Based In-situ Measurements

Ground-based exposure rate measurements using pressurized ionization chamber (PIC) were acquired at three sites within the survey area. The sites were selected based on their uniform values of the exposure rates derived from the aerial results. These measurements were taken to support and verify the integrity of the aerial data. At each site, measurements were taken at three spatially separated locations for a total of nine measurements. Each measurement was an average of 10 individual PIC readings. The PIC measurements were taken at a height of 1 meter AGL. The PIC measurements were consistent with the aerial data within statistical error.

Exposure Rate Maps

Figures 3 and 4 contain color-coded exposure rate maps for the surveyed area. The exposure rate variability observed within the map is typical of that produced by differences in geology, building and paving materials, and natural ground cover. The map in Figure 3 shows an exposure rate "bullseye" (5.2-7.0 uR/hr) caused by The National World War II Memorial. The elevated exposure rates from mobile data shown in Figure 4 are all of natural origin, caused by the building materials containing naturally occurring radioisotopes.

Man-Made Activity Algorithm

Man-made source activity is often hidden within the relatively large variations of gross counts observed from normal environmental background radioactivity. A special "man-made" algorithm utilizes gamma spectral information to suppress environmental activity and highlight man-made activity component. In regions with only natural environmental activity, the indicated activity is nominally zero. For elevated low-energy activity (below 1400 keV, typical of man-made isotopes), the algorithm gives a positive number. For elevated high-energy activity (above 1400 keV, which is atypical), the algorithm gives a negative number. For this surveys, the man-made "lowest statistically significant" level was set at $\pm 500\,cps$ in order to significantly reduce the presence of statistical false positives. Mathematically, the man-made algorithm has the form:

$$MM = A - kB$$

Where we have:

$MM\left[cps\right] \equiv$ Man-made activity

$A\left[cps\right] \equiv$ Integral count rate in the spectral window $\left(38\,KeV \rightarrow 1394\,KeV\right)$

$B\left[cps\right] \equiv$ Integral count rate in the spectral window $\left(1394\,KeV \rightarrow 3026\,KeV\right)$

$k \equiv$ Empirically obtained mean window ratio obtained from area of no man-made activity

Man-Made Activity Maps

Figures 5 is a color-coded, man-made activity map for the surveyed area. There were no observed areas indicating statistically significant man-made activity.

Gross Neutron Maps

The contour plot of the moderated neutron count rate over surveyed area is presented in Figure 6. The values are consistent with the natural background neutron count rate of 1-24 cps measured over water and land in Maryland at the Chesapeake Bay and Calvert County Test Line, and in Nevada over Lake Mead and the Government Wash basin, respectively.

Summary

The radiation background survey carried out over downtown Washington, DC shows typical variations in the natural background radiation. The measured values varied from 0 to 7 μR/hr, with radon and cosmic contributions removed. For comparison, Figure 7 shows the levels of the terrestrial natural background levels across the United States covering the same range of values as measured during this survey.

Final Products

RSL final map products include paper and electronic (pdf format) contour maps of gross-count derived exposure rates and man-made gross counts for the downtown Washington, DC area. In addition, a CD with GIS shape files in ESRI ArcMap 9.3 format, Adobe pdf images, and aerial photographs of the surveyed areas are being provided.

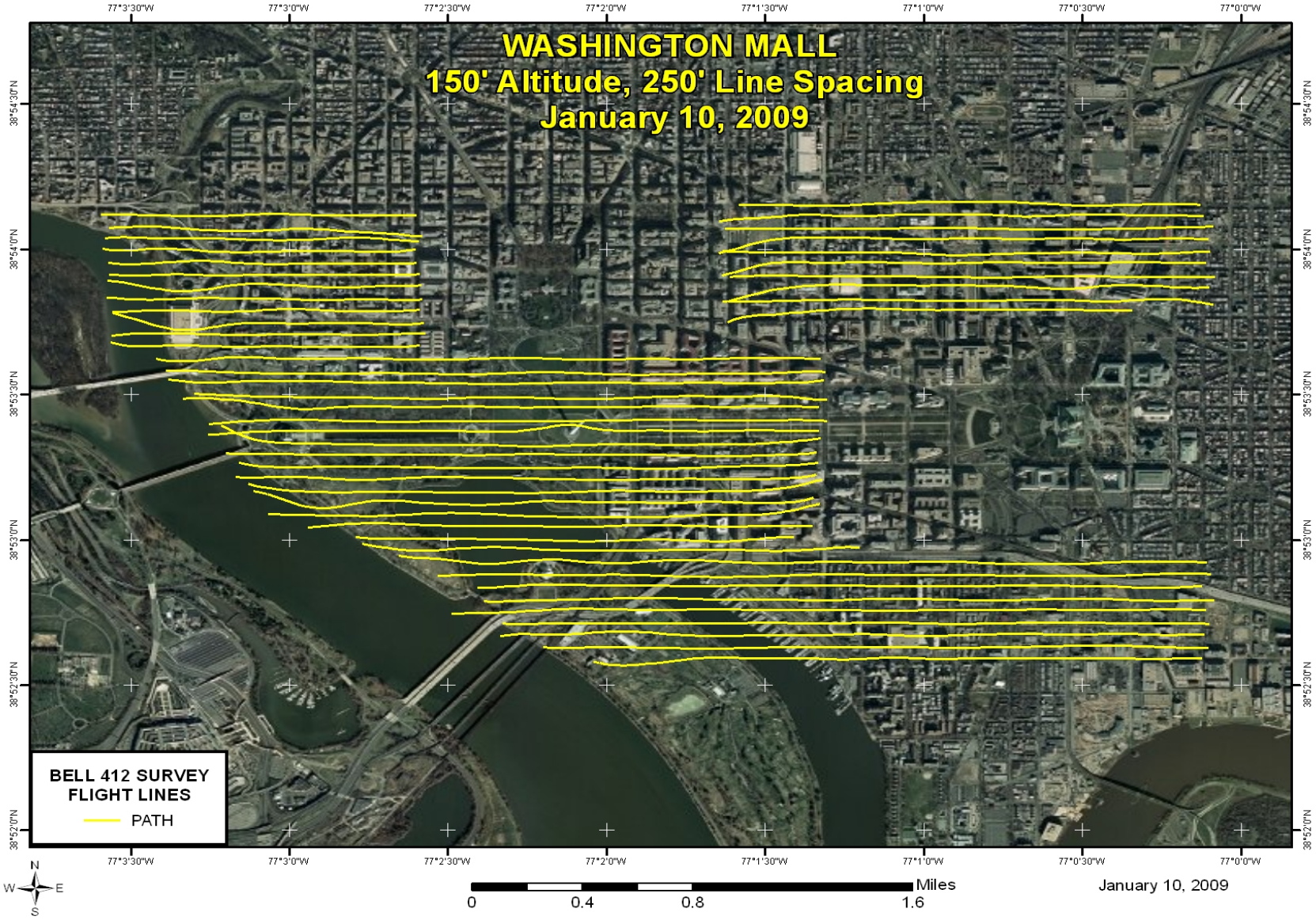

Figure 1 - Aerial Coverage Area

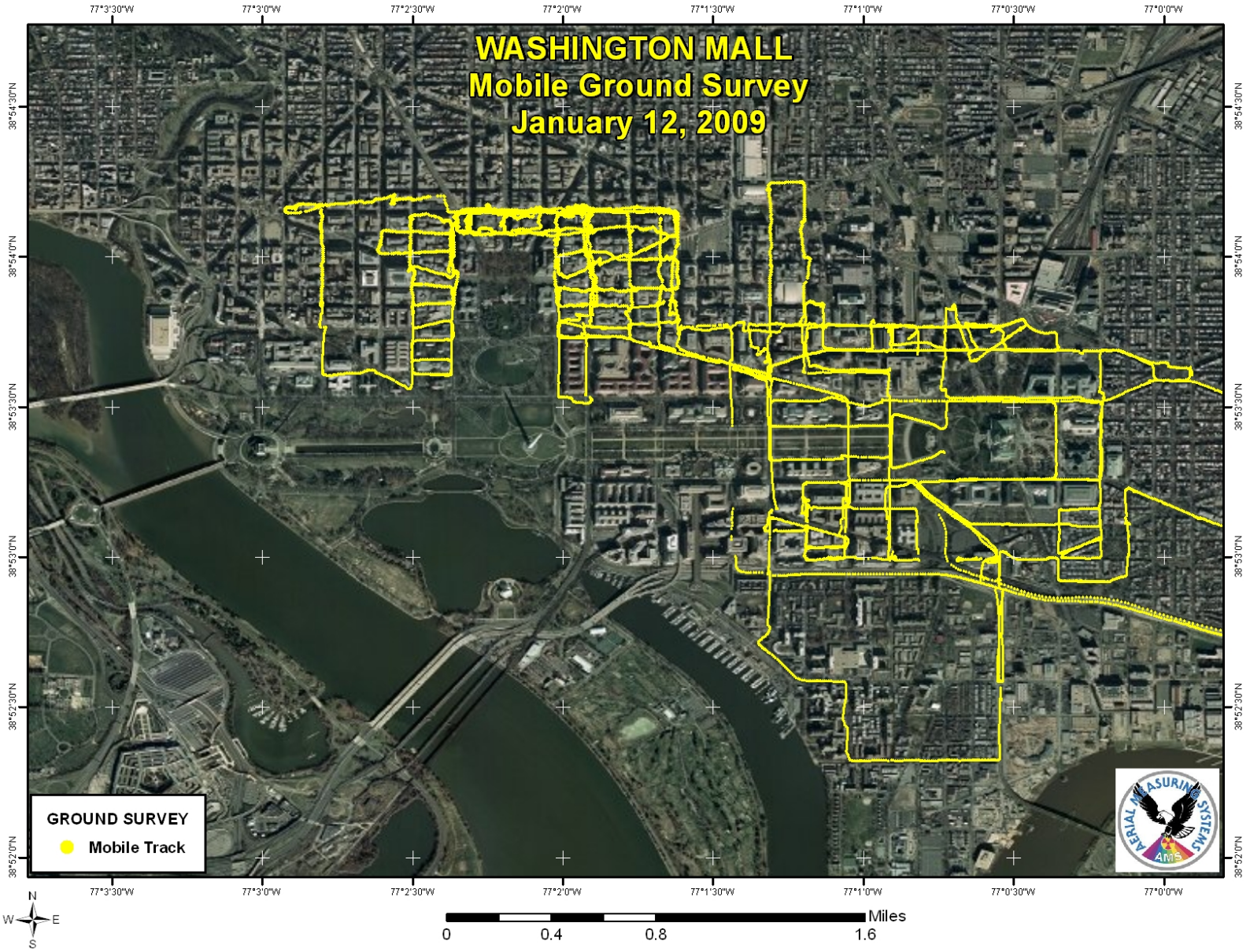

Figure 2 - Mobile Coverage Area

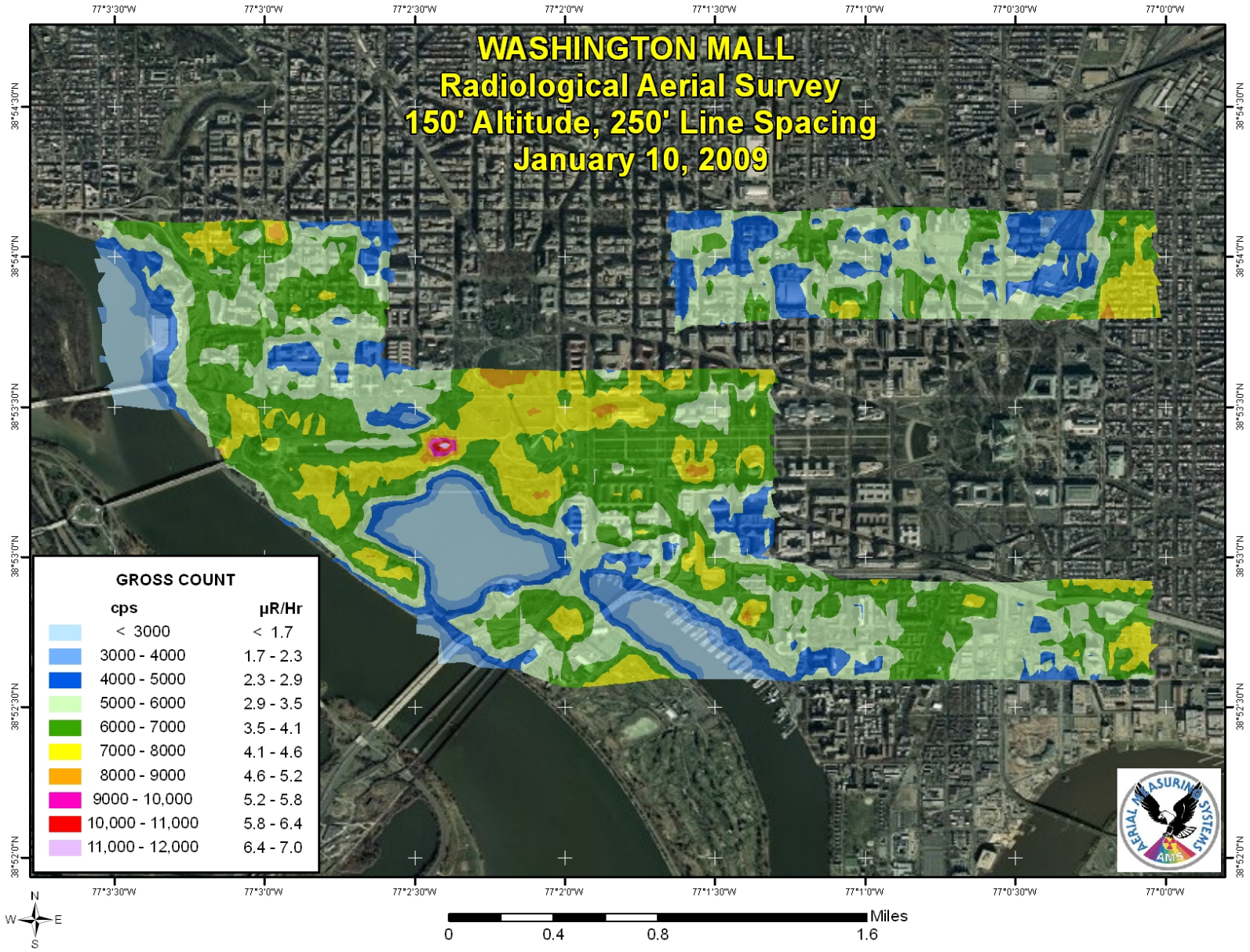

Figure 3 - Aerial Exposure Rate at 1m Above Ground Level

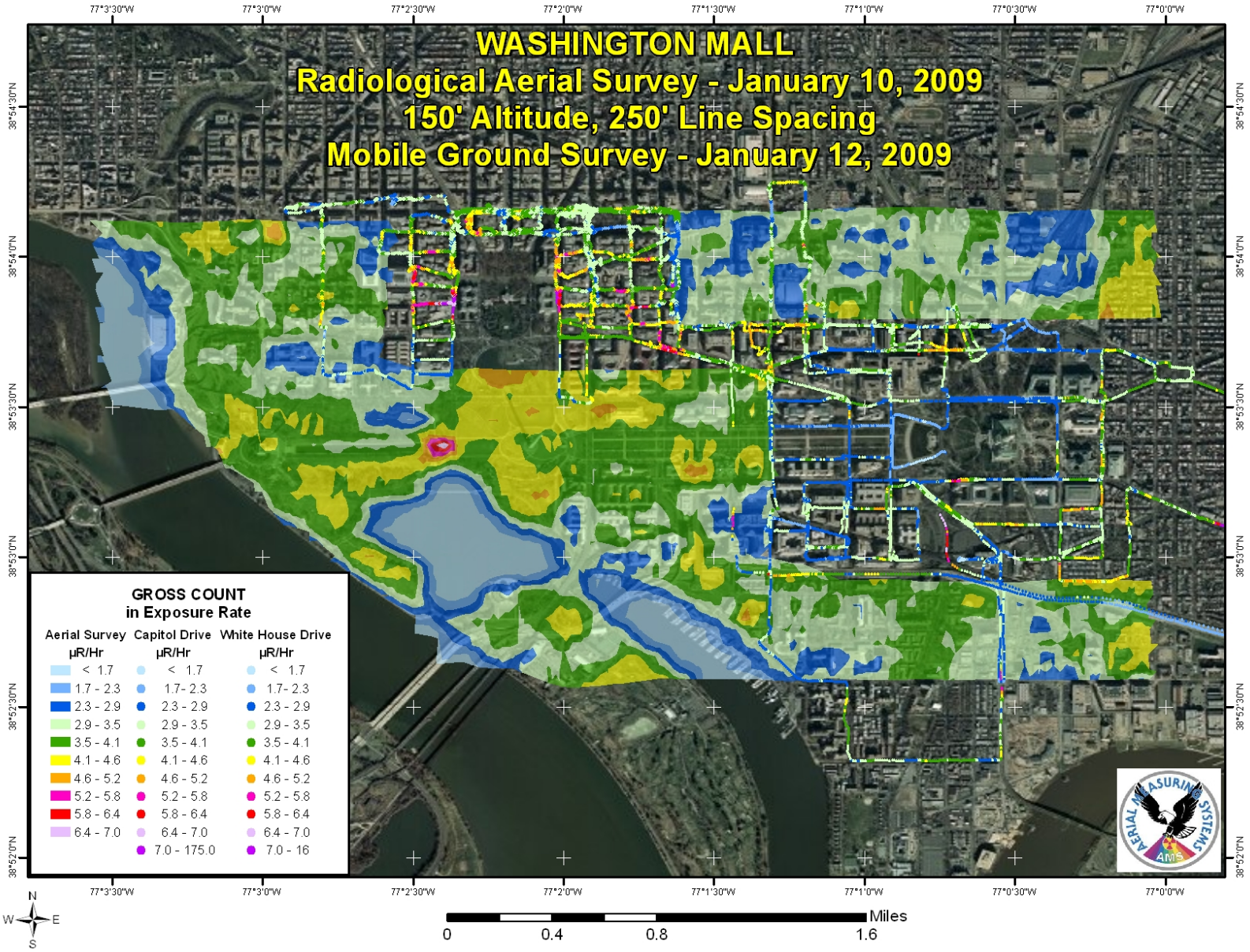

Figure 4 – Aerial and Mobile Exposure Rate at 1m Above Ground Level

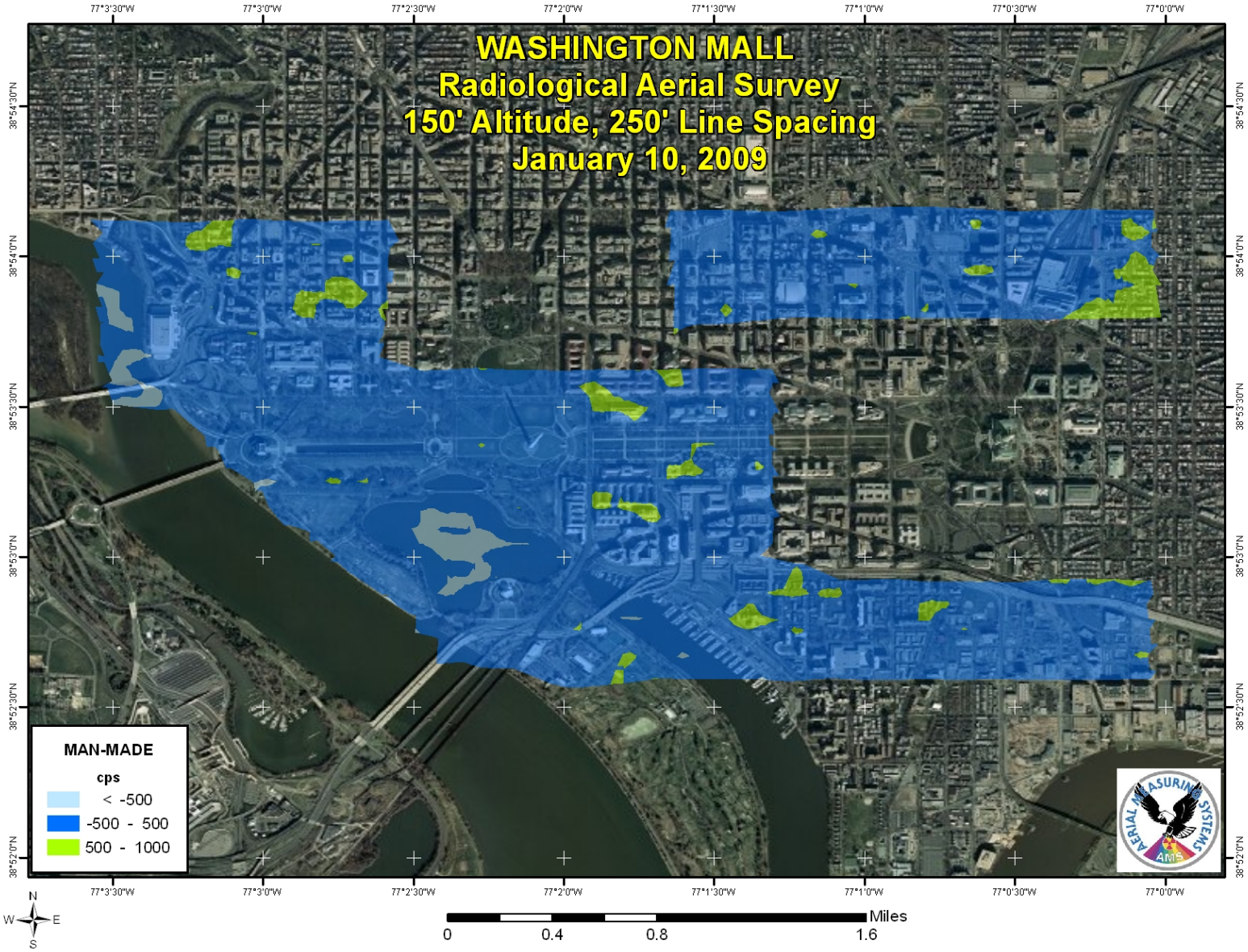

Figure 5 – Man-Made Activity

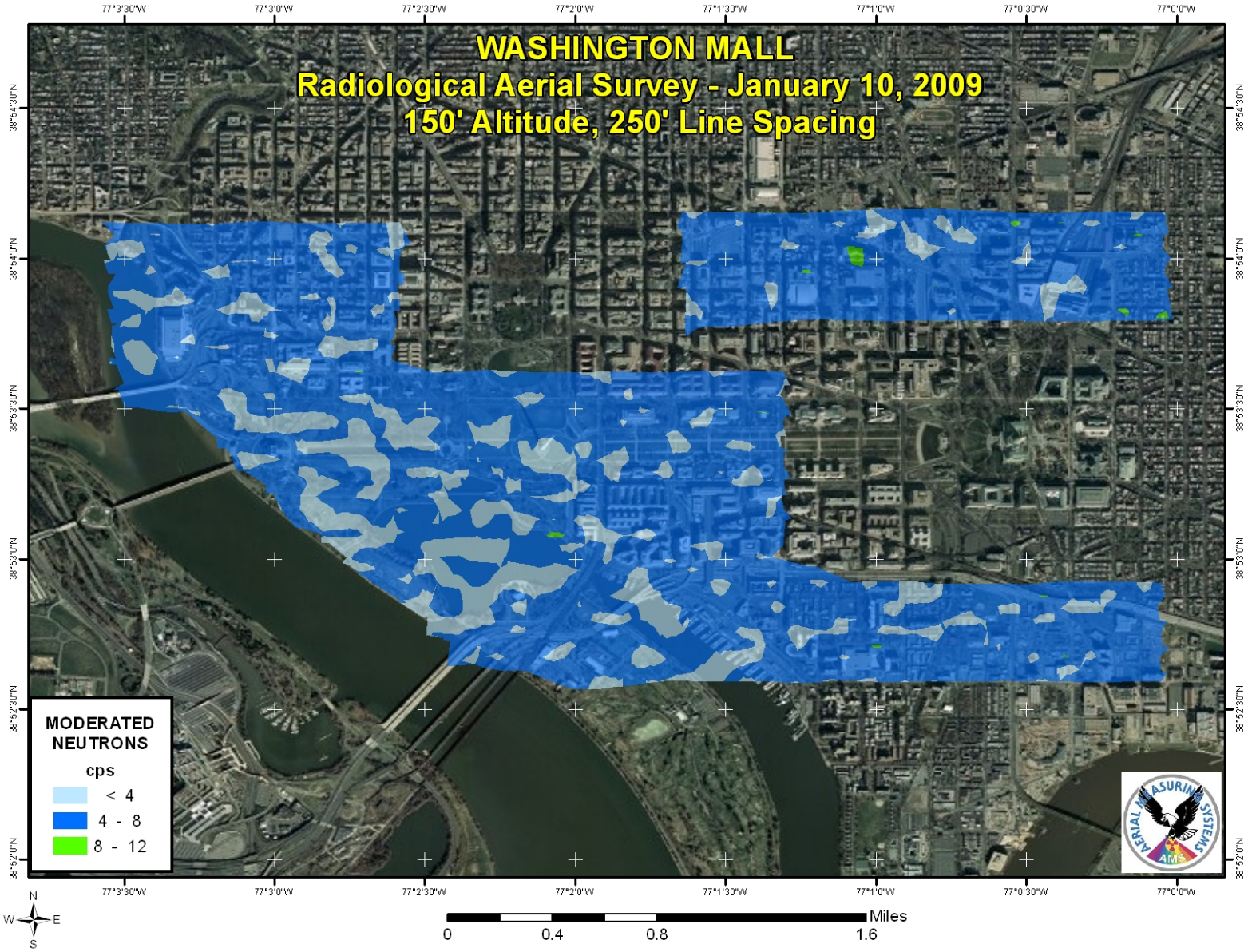

Figure 6 - Moderated Neutron Activity

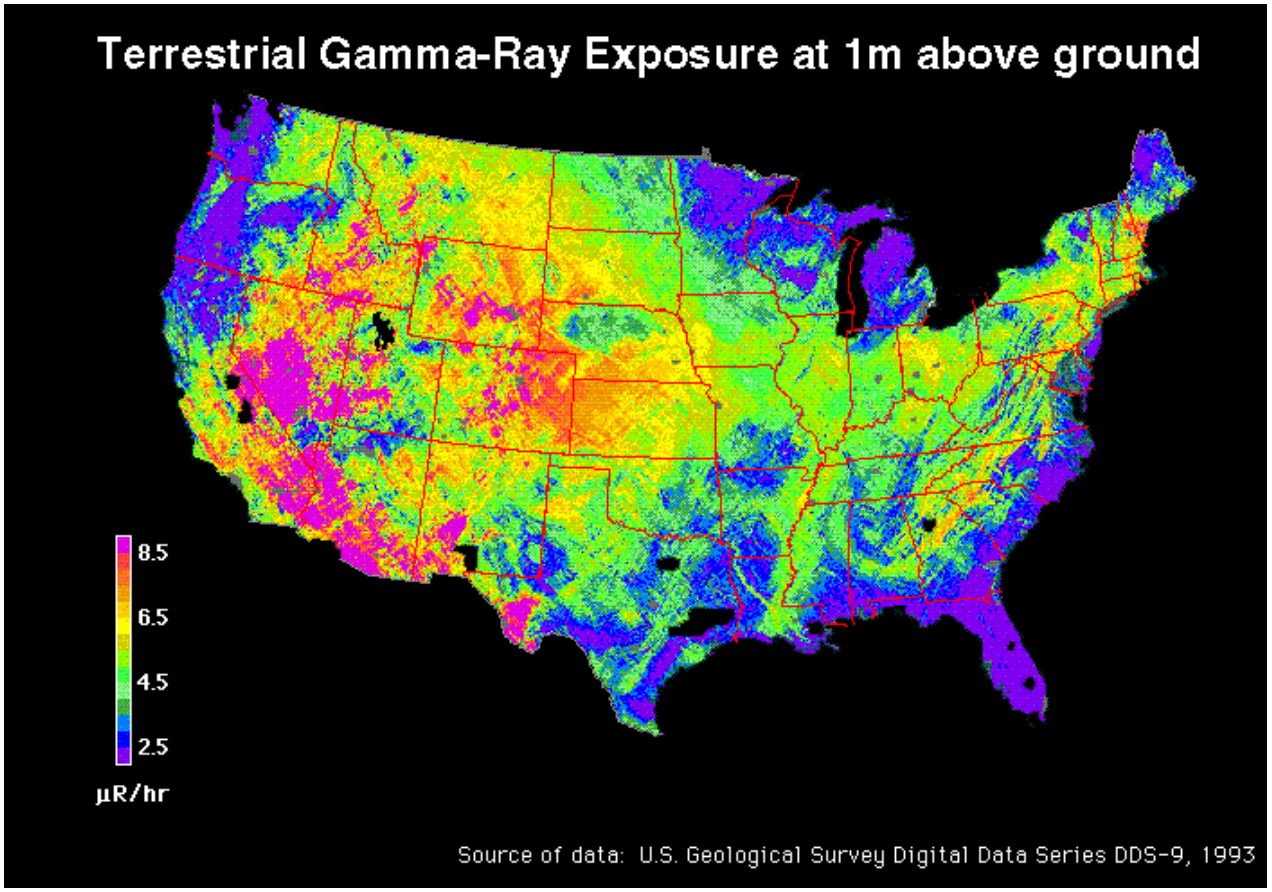

Figure 7 - Terrestrial Gamma-Ray Exposure at 1m Above Ground

AMS Survey Personnel and Parameters

AMS Mission Personnel	
Name	**Position**
Jerald Bond	Federal Team Lead
Carrie Fitzgerald	AMS Mission Manager
Piotr Wasiolek	AMS Mission Manager
Joseph Ginanni	Federal AMS Manager
Karen McCall	AMS Manager
Jeff LeDonne	Pilot
Emmanuel Avaro	Pilot
Jez Stampahar	Data Analyst
Mike Lukens	Electronic Technician
Kevin Borders	Electronic Technician
Thomas Lawrence	Mechanic

Survey Parameters	
Name of Location	**D.C. Area**
Length	3.1 Miles
Width	1.8 Miles
Type of Survey	Background/proficiency
Number of Areas	One
Coverage	5.32 square miles
Altitude	150 feet
Speed	70 knots
Line Spacing	250 feet
Average Line Length	3.1 Miles
Steering	
Base latitude (degrees)	38.8875
Base longitude (degrees)	-77.0541667
Angle (degrees)	0